Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Fourth Annual Report and Analysis of	)	IB Docket No. 10-99
Competitive Market Conditions with Respect	)	
to Domestic and International Satellite	)	
Communications Services	)	

JOINT COMMENTS OF ECHOSTAR CORPORATION, INTELSAT GLOBAL S.A., SES WORLD SKIES, AND TELESAT CANADA

EchoStar Corporation, Intelsat Global S.A., SES WORLD SKIES, and Telesat Canada (together, the "Satellite Commenters") hereby submit these comments in response to the Federal Communication Commission's ("FCC" or the "Commission") Public Notice in the above-captioned proceeding.[1] The Satellite Commenters are filing these comments to urge the Commission to examine carefully the state of competition for satellite launch services.

For its fourth annual report to Congress, the Commission requests comments on, among other things, the extent to which providers of inputs to satellite services "exercise bargaining power . . . that constrains the financial performance, pricing decisions, innovation, capacity expansion, or corporate strategy options" of satellite operators.[2] Commercial satellite operators currently have very limited options for choosing a launch service provider.

In the U.S., launch providers primarily serve the U.S. government and necessarily

[1] "International Bureau Invites Comment for Fourth Annual Report to Congress on Status of Competition in the Satellite Services Industry," Public Notice, DA 10-1353, IB Docket No. 10-99 (July 22, 2010) ("Public Notice").

[2] Public Notice, Part I.B., at 3.

accommodate its launch requirements.[3] Launches designed for U.S. government use often must be very specifically tailored to mission-specific needs and generally are not easily adaptable to commercial use. U.S. launchers also tend to lack reliable scheduling since government launches take priority over commercial launches, which have sometimes lost launch slots when government schedules changed.[4] Thus, U.S. launch services generally are not seen as a reliable alternative for commercial satellite operators.

Among international launch providers, U.S. commercial satellite operators have few options. U.S. policies relating to satellites containing components regulated under ITAR foreclose access to Chinese launch services except with hard-to-obtain Presidential approval.[5] Sea Launch, another launch service provider, is currently attempting to emerge from bankruptcy proceedings and, even if successful, will not be in a position to launch for about a year.[6] This leaves Arianespace and International Launch Services (ILS) as the only remaining near-term options for commercial satellite operators seeking to launch U.S.-built satellites.

The Center for Strategic & International Studies (CSIS) just last month issued a report addressing many of these issues, and explicitly recognizing the linkage between U.S. national security and access to space for commercial satellites. This report, "National Security and the Commercial Space Sector," is enclosed as an appendix to these comments. The Satellite

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[3] *See* Center for Strategic and International Studies, National Security and the Commercial Space Sector: An Analysis and Evaluation of Options for Improving Commercial Access to Space, at 18-19 (July 2010), attached hereto and available at http://csis.org/files/publication/100726_Berteau_CommcialSpace_WEB.pdf ("CSIS Report").

[4] *Id.*

[5] *See id.*

[6] *See* U.S. Bankruptcy Court Approves Sea Launch Reorganization Plan, Satellite Today (July 28, 2010), *available at* http://www.satellitetoday.com/st/headlines/U-S-Bankruptcy-Court-Approves-Sea-Launch-Reorganization-Plan_34662.html (last visited Aug. 20, 2010).

Commenters do not endorse every conclusion in the CSIS report, but believe that it provides important information for the Commission to consider in the context of the competitiveness of the commercial satellite launch sector.

Respectfully Submitted,

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August 23, 2010

National Security and the Commercial Space Sector

An Analysis and Evaluation of Options for Improving Commercial Access to Space

A Report of the CSIS Defense-Industrial Initiatives Group

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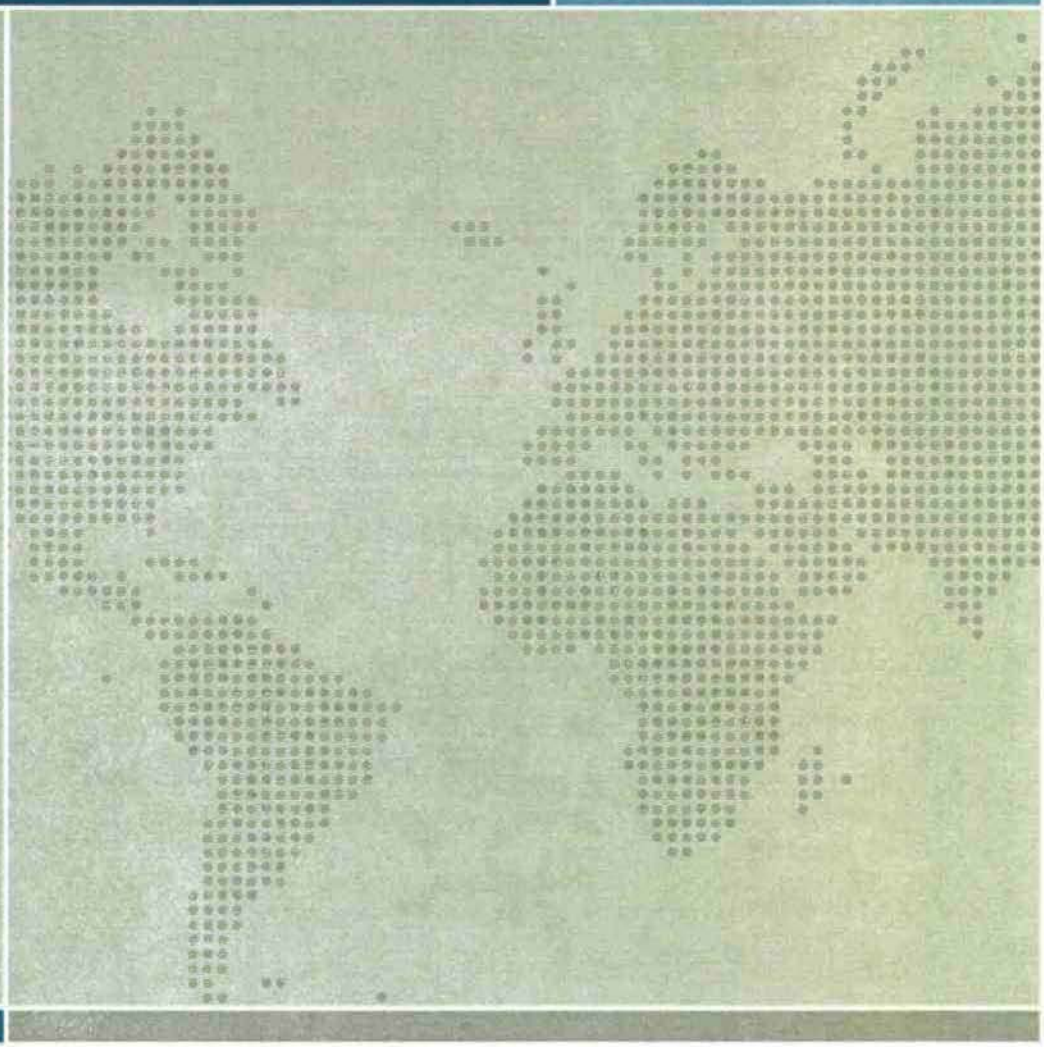

July 2010

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

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About CSIS

In an era of ever-changing global opportunities and challenges, the Center for Strategic and International Studies (CSIS) provides strategic insights and practical policy solutions to decision-makers. CSIS conducts research and analysis and develops policy initiatives that look into the future and anticipate change.

Founded by David M. Abshire and Admiral Arleigh Burke at the height of the Cold War, CSIS was dedicated to the simple but urgent goal of finding ways for America to survive as a nation and prosper as a people. Since 1962, CSIS has grown to become one of the world's preeminent public policy institutions.

Today, CSIS is a bipartisan, nonprofit organization headquartered in Washington, D.C. More than 220 full-time staff and a large network of affiliated scholars focus their expertise on defense and security; on the world's regions and the unique challenges inherent to them; and on the issues that know no boundary in an increasingly connected world.

Former U.S. senator Sam Nunn became chairman of the CSIS Board of Trustees in 1999, and John J. Hamre has led CSIS as its president and chief executive officer since 2000.

CSIS does not take specific policy positions; accordingly, all views expressed in this publication should be understood to be solely those of the authors.

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ACKNOWLEDGMENTS

This report of the CSIS Defense-Industrial Initiatives Group would not have been possible without the ongoing assistance and support from many people and organizations. CSIS recognizes the many individuals who volunteered their time and expertise throughout the course of this study. We are extremely grateful for the input of our interviewees and working group participants, including key current and former officials and personnel in government, industry, and academia. Our methodology of off-the-record, not-for-attribution interviews precludes us from mentioning outside participants by name, but we remain indebted to them for generously giving of their time and counsel. As with most projects of the CSIS Defense-Industrial Initiatives Group, we are grateful for the sponsorship of companies whose support makes possible our core analytical capabilities and reports such as these.

In addition, the project directors would like to thank the principal authors, Guy Ben-Ari, one of the original authors of the CSIS 2008 space study, "Health of the U.S. Space Industrial Base and the Impact of Export Control," and Brian Green, former deputy assistant secretary of defense and now with Systems Planning and Analysis, Inc. Gary Powell, Stephanie Sanok, and Joshua Hartman also provided invaluable input as well as sections of written material. Finally, we are extremely appreciative of the research, writing, editing, and administrative support of our other contributors: Lindsey Ohmit, Tara Callahan, Greg Sanders, and Thomas Patterson.

The project directors and authors are solely responsible for the contents and judgments in this report.

OVERVIEW

In this report, the Center for Strategic and International Studies (CSIS) examines the relationship between U.S. national security and the commercial space sector, with specific focus on the current state of the space launch industry and launch market. Building on a CSIS annotated briefing released in 2008, entitled "Health of the U.S. Space Industrial Base and the Impact of Export Controls," this report describes the importance of the commercial space sector to U.S. national security, catalogues several principal concerns regarding commercial access to space, provides a framework for analyzing options to improve access to commercial launch services, and then evaluates those options. This report is a vehicle for further discussion of two key issues: the relationship between the commercial space sector and national security, and the ways in which U.S. policymakers might better manage the nexus between them.

Introduction

During the past decade, CSIS has consistently reported on concerns about the state of the space industry. During that same period, the United States has experienced an ever-increasing reliance on space in the daily lives of its citizens and, significantly, in national security. Distilled to its core findings, this report concludes that commercial space assets and services are critical to U.S. national security and economic health and, because commercial space is critical, assured access to space for commercial payloads should be an important U.S. national security priority. Nevertheless, access to space for commercial satellites today is problematic in important respects, and explanations for these problems can be found in a combination of U.S. policy and the current state of the space launch industry. Based on these considerations, CSIS then developed and evaluated option sets to improve commercial access to space.

This study is divided into five parts. Part 1 discusses the relevance of the commercial space sector to national security. This first section addresses the question of why policymakers should care, a question often asked by those who study, write, and implement public policy. During an interview with CSIS, one senior commercial satellite company official stated, "Our key concern is how to put capacity on orbit." In Part 1, the report first evaluates whether this concern should also be a U.S. national security priority.

Part 2 describes the current state of the commercial space launch market—the federal policies and directives governing space launch, international and domestic capacity, and expected global demand. This section validates the concerns voiced by government officials, commercial industry, and others with regard to commercial access to space and "getting satellites on orbit."

Part 3 outlines a series of options that could improve commercial access to space with a concomitant benefit to U.S. national security interests. These options represent broad policy

approaches available to decisionmakers and are based on discussions with experts interviewed by CSIS as well as future policies, directives, and actions currently under consideration by the administration.

Part 4 defines a set of criteria by which to evaluate the options outlined in Part 3.

Part 5 presents the CSIS evaluation of the option sets using the evaluation criteria.

The examination of issues in this report demonstrates the critical nexus between the commercial space sector and national security. The analysis asks vital questions about the best way forward for both the public and private sectors, pointing to possible solutions that meet the goals and objectives of both.

Methodology

This report builds on a CSIS annotated briefing released in 2008, entitled "Health of the U.S. Space Industrial Base and the Impact of Export Controls." For this assessment, CSIS updated the 2008 analysis, in part to help inform and support policymakers in the new administration.

CSIS released a draft report for comment approximately two months into our research and writing. CSIS received additional input from interested parties following the public release of the draft report. CSIS appreciates the many thoughtful comments and the time and effort that so many commenters put into crafting them. CSIS used this input to correct errors, clarify points, and sharpen arguments in the final report.

A substantial amount of information for this analysis and evaluation was collected through extensive interviews with key policymakers and leading experts in government, industry (both U.S. and foreign), and academia. To encourage interviewees to speak freely, all interviews were conducted on an off-the-record, not-for-attribution basis. CSIS conducted more than 110 group and individual interviews in the preparation of this report.

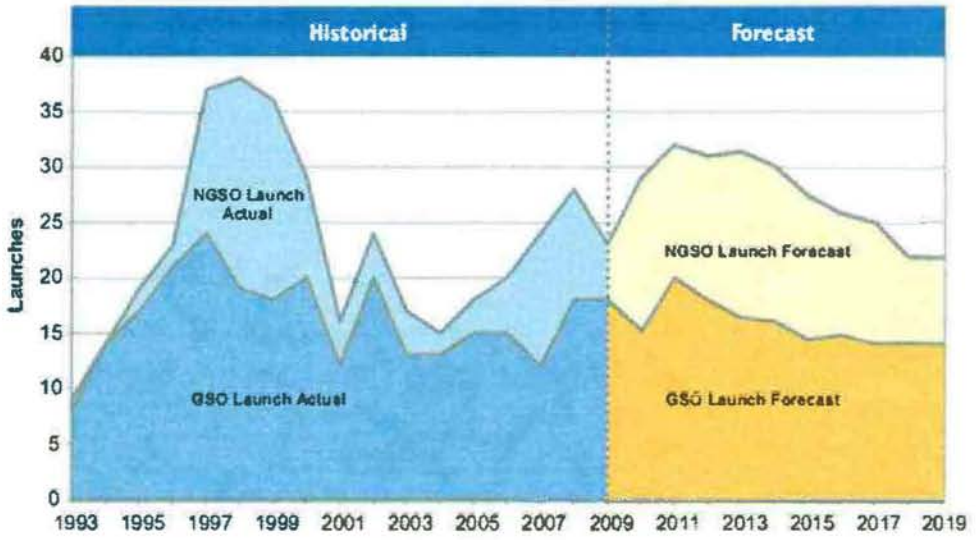
CSIS researchers interacted with individuals involved in many of the dozens of space launch studies conducted within and for the U.S. government that are ongoing or have been recently completed.[1] CSIS also reviewed extensive secondary data from organizations including Futron, the Federal Aviation Administration (FAA), the U.S. Department of Commerce (DoC), and the Department of Defense (DoD). The concerns, option sets, and evaluation criteria included in this report were all informed by both these primary and secondary sources. The representations here are entirely the product of the project directors and the authors, and they are solely responsible for any factual or analytical errors that may be contained herein.

This study focuses on launch services for medium to heavy payloads,[2] which are the most challenging to launch into *geosynchronous* orbit and which account for the majority of the launch

1. CSIS was presented a listing of 22 specific reports, but other interviewees cited between 17 and 29 ongoing or recently completed efforts. No interviewee was able to reference all 29.

2. FAA defines four categories of launch vehicles: light, medium, intermediate, and heavy. Medium to heavy lift launch vehicles can launch roughly 2.5 to 15 tons of payload to geosynchronous transfer orbit (GTO). Light launch vehicles are more typically focused on low earth orbit, but at least one such vehicle can launch about 1,000 pounds to GTO. See *2010 U.S. Commercial Space Transportation Development and Concepts: Vehicles, Technologies and Spaceports* (Washington, D.C.: Federal Aviation Administration, January 2010), 2.

Figure A. Federal Aviation Administration Geosynchronous Orbit and Non-Geosynchronous Orbit Historical Launches And Launch Forecasts, 1993–2019



Source: FAA Commercial Space Transportation and Commercial Space Transportation Advisory Committee, *2010 Commercial Space Transportation Forecasts* (Washington, D.C.: FAA, May 2010), 3.

market (see Figure A).[3] In these categories of launch vehicles, providers, and payloads, the connectivity between the commercial and national security space sectors is immediate and pronounced, and the concerns related to assured access to space, the U.S. space industrial base, and loss of U.S. leadership are significant. CSIS also recognizes the importance of satellites and their payloads in non-geosynchronous orbit to both the commercial and national security interests of the United States and the corresponding importance of reliable low- and medium-earth orbit launch capabilities. However, given the time and resource constraints CSIS faced and the unique nature of many of the challenges in lower orbital regimes, smaller launch vehicles and launch providers for non-geosynchronous orbit—including spaceports promoted by individual states such as Virginia, New Mexico, Alaska, and Florida—remained largely outside the immediate scope of this effort. The effect of the smaller classes of launch vehicles, providers, and payloads on both the national security and commercial space sectors is already great, will likely grow, and is deserving of its own study.

3. Office of Commercial Space Transportation, Federal Aviation Administration, *2010 Commercial Space Transportation Forecasts*, May 2010, 3, http://www.faa.gov/about/office_org/headquarters_offices/ast/media/launch_forecasts_051810.pdf.

1 WHY SHOULD POLICYMAKERS CARE ABOUT COMMERCIAL ACCESS TO SPACE?

Decisionmakers often ask those advocating for a particular cause for an answer to the critical question: Why should I care? Thus, before addressing the concerns of the commercial space sector's access to space, CSIS first examined the extent to which commercial access should be a concern of U.S. policymakers. Based on its investigations, CSIS has concluded that decisionmakers should care for two fundamental reasons. First, space assets provide capabilities that are critical to U.S. national security, and commercial space assets account for many of these capabilities. In short, commercial space assets are critical to U.S. security, and, as outlined below, U.S. policy should address assured access to space for key commercial payloads. Second, CSIS interviews revealed widespread concerns about threats or impediments to the commercial sector's access to space (section D). While not every interviewee recognized all the concerns listed, very few saw no cause for apprehension at all. The issues discussed in this report are important to the space policy and acquisition communities in the U.S. government because they illuminate a vital link between national security and the commercial space sector as well as a consensus that commercial access to space launch is problematic.

A. U.S. national policy requires assured access to space for national security assets, and this requirement has been U.S. policy for decades.[1]

The importance of space to national security has become increasingly self-evident to U.S. policymakers and warfighters. The 2008 CSIS space study noted accurately that this importance is in no danger of diminishing.

Eight principles formed the basis for the findings and recommendations in the 2008 report, and they remain valid today:

A.1. Space is critically important to U.S. national security. From command and control to communications and intelligence gathering to weapons targeting, space systems today are a key element of U.S. national security. Space systems are increasingly important for monitoring potential threats, managing military forces, and carrying out combat operations.[2]

A.2. Space is an essential dimension of the U.S. economy. Many space technologies have

1. A 2006 article by Gen. Thomas Moorman in High Frontier stated that the term "assured access to space" was coined in 1983 but traces its roots to the earliest days of the Air Force's involvement in space. See Gen. Thomas S. Moorman Jr. (USAF, Ret.), "Framing the Assured Access Debate: A Brief History of Air Force Space Launch," High Frontier 3, no. 1 (November 2006).

2. See, for example, Ted Molczan and John Pike, "Tables of Operational Military Satellites," GlobalSecurity.org, December 2005, http://www.globalsecurity.org/space/library/report/200/satellitetables2004.htm.

reached such a level of maturity that some of their applications, such as telecommunications, automated teller machines, meteorology, navigation, stock market data, and transport control, are now an integral part of the daily lives of millions of U.S. residents.

A.3. Global leadership in space for the United States is important. It provides decision-makers with critical intelligence, warfighters with a technological advantage on the battlefield, and citizens with services upon which they have come to depend. Furthermore, leadership in space contributes to U.S. soft power and prestige on the international stage.

A.4. Sustaining U.S. technological superiority in space is a U.S. national security interest. It is impossible to imagine achieving this superiority while relying primarily on foreign capabilities. Given the importance of space assets to national security, it is imperative that U.S. technical superiority in space be homegrown.

A.5. All of the segments of the U.S. space community are highly interdependent. As demonstrated in Figure 1.1, the defense, intelligence, civil, and commercial sectors of space overlap in many critical areas. This means that damage to any one of these sectors reverberates through all the others.

A.6. A strong space industrial base is important. While the Cold War era was characterized by mostly military activity in space, the post–Cold War era has seen a surge in the private sector's involvement in space activities. Today, when space-based capabilities are increasingly important for national security and the economy, government agencies worldwide are contracting space programs and services out to the private sector.[3]

A.7. The space industry—though small compared with other manufacturing sectors—possesses strategic significance beyond its size. In addition to its critical role in providing systems and services to government, it also generates knowledge and innovation; by establishing new companies based on that innovation, the U.S. space industrial base is an important element of national security and in generating the nation's economic growth.

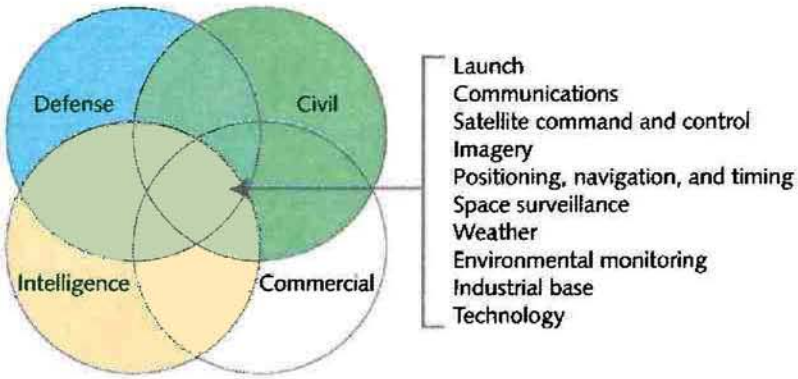
A.8. The United States must have unimpeded access to the technologies, both global and domestic, that are needed for developing, operating, and maintaining national security space systems. Although some—possibly most—of these technologies can be provided by the domestic science, technology, and industrial bases, others, including critical systems, subsystems, and components, may only be available overseas.

The enduring relevance of these principles is highlighted by the 2010 National Security Strategy, which emphasized the importance of U.S. space capabilities and touched on most of the themes in the 2008 CSIS report:

> For over 50 years, our space community has been a catalyst for innovation and a hallmark of U.S. technological leadership. Our space capabilities underpin global commerce and scientific advancements and bolster our national security strengths and those of our allies and partners. . . . We must continue to encourage cutting-edge space technology by investing in the people and industrial base that develops them. We will invest in the research and development of next-generation space technologies and . . . we will promote a unified effort to strengthen our

3. Michael Krepon, *Space Assurance or Space Dominance: The Case against Weaponizing Space,* with Christopher Clary (Washington, D.C.: The Stimson Center, 2003), 8–9.

Figure 1.1. Space Sector Interdependence



Source: CSIS Defense-Industrial Initiatives Group concept.

space industrial base and work with universities to encourage students to pursue space-related careers.[4]

B. Commercial satellite services are critical to national security.

Although space has been a facet of U.S. national security policy for decades, the United States today is more reliant on space programs, and the international community is playing a larger role in space. These factors elevate the importance of space within U.S. policy considerations to an even higher level. In August 2008, Scott Large, the then head of the National Reconnaissance Office (NRO), summed up the argument:

> Today, America's concept of national security space no longer encompasses only classified and unclassified defense and intelligence space systems, but includes all forms of space systems (including civil and commercial), as well as a growing use of foreign space capabilities . . . . In the information age, private global communications form the backbone of America's economic well-being. Additionally, these systems carry a large percentage of the nation's military data, critically augmenting America's military satellite communication architecture. This blending of commerce and defense data transmission demonstrates the commercial space sector's national importance. Although civil, commercial, classified and unclassified space systems support different missions, each has unique capabilities that play vital roles in maintaining America's financial and military security.[5]

Thus, the NRO recognized that commercial satellite services are integral to the national security of the United States as well as American life and commerce.

Services provided by the commercial space sector are thoroughly embedded in the American way of life. Communications, banking, weather, and navigation systems all rely on the commercial

4. *National Security Strategy* (Washington, D.C.: The White House, May 2010).

5. Scott Large, "National Security Space Collaboration as a National Defense Imperative," High Frontier 4, no. 4 (August 2008), 3–5.

space sector. In their everyday lives, very few, if any, Americans are unaffected by the commercial space sector. The importance of maintaining the critical infrastructure providing this capability cannot be overestimated.

Regarding national security, current and projected military operations are inextricably linked to commercial space assets. Recent DoD war games, such as the George C. Marshall Institute's "A Day without Space" exercise and the Schriever Wargame Series, have brought key senior leaders together to demonstrate and underscore the criticality of the commercial space sector.[6] This was reinforced by Gen. Ronald R. Fogleman (USAF, Ret.), who stated at a recent CSIS forum that the Schriever war games demonstrate that "commercial space is already a vital part of the military space capability. It's not going to change. It's only going to grow in capability."[7]

One recent news article, entitled "DoD's Reliance on Commercial Satellites Hits New Zenith," highlighted the importance of commercial space to U.S. national security.[8] The communications bandwidth needs of the U.S. State Department, the U.S. Department of Defense, and U.S. coalition forces have increased tremendously during the past 20 years, and military satellite communications capacity falls far short of meeting demand. As a result, the U.S. government now relies on commercial satellite providers for 80 percent of its total capacity to meet mission requirements, and according to multiple sources, up to 96 percent of satellite communications for the military in battle arenas such as Iraq and Afghanistan are provided by commercial communications satellites.[9] And the need continues to increase. According to a recent Institute for Defense Analyses study, the communications bandwidth employed for Operation Iraqi Freedom today is more than 100 times the bandwidth employed at the peak of the first Gulf War.[10] New data-intensive applications, such as unmanned aerial vehicles, weapons targeting, and data transmission platforms are increasing bandwidth requirements.[11]

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6. George C. Marshall Institute and the Space Enterprise Council, "A Day without Space: Economic Security Ramifications," http://www.marshall.org/article.php?id=778; "Wyle Experts Play Vital Role in Recently Completed Schriever Space Wargame," Wyle, July 24, 2009, http://www.wyle.com/news/2009/02-24.htm; Marty Kauchak, "Q&A: Lieutenant General Larry D. James," Military Space & Missile Forum 2, no. 6 (November/December 2009), http://www.kmimediagroup.com/msmf-archives/213-msmf-2009-volume-2-issue-6/2198-qaa-lieutenant-general-larry-d-james.html.

7. Lt. Gen. Mike Hamel (USAF, Ret.), Mr. Jeffrey K. Harris, and General Ronald R. Fogleman (USAF, Ret.), "How to Stigmatize the Use of Cyber and Anti-Satellite Attack" (panel discussion at the CSIS Global Strategy Forum, Four Seasons Hotel, Washington, D.C., May 13, 2010).

8. Barry Rosenberg, "DoD's Reliance on Commercial Satellites Hits New Zenith," Defense Systems, February 25, 2010, http://www.defensesystems.com/Articles/2010/03/11/Cover-story-The-Satcom-Challenge.aspx.

9. Ibid.; David Cavossa, Charles Edwards, Kevin Gallo, Brig. Gen. Tip Osterthaler (Ret.), and Michael Wheeler, "New Approaches to Commercial Satcom Procurement: Fulfilling the Needs of the USG and DoD" (panel discussion at the Satellite 2010 Conference, National Harbor, Maryland, March 16, 2010).

10. Institute for Defense Analyses, *Leadership, Management, and Organization for National Security Space: Report to Congress on the Organization and Management of National Security Space* (Alexandria, Va.: Institute for Defense Analyses, 2008).

11. "Over 80 Percent of U.S. Military Capacity Provided by Commercial Satellites," *Satellite News*, May 20, 2009, http://www.allbusiness.com/defense-aerospace/aerospace-industry-space/12473258-1.html; Peter B. de Selding, "U.S. Government Missing Hosted Payload Opportunities," *Space News*, March 26, 2010, http://www.spacenews.com/civil/100326-govt-missing-hosted-payload-opportunities.html; "Looking to the Future of Satellite Bandwidth Procurement," *Military Information Technology* 13, no. 5 (June 2009).

In addition to communications, commercial space assets provide a critical supplement to U.S. government imagery capabilities. The National Geospatial-Intelligence Agency (NGA) acquires images from commercial imagery satellites and disseminates them to government consumers. These capabilities provide high-quality imagery (down to about a half meter resolution) and substantial imaging capacity beyond that of government intelligence, surveillance, and reconnaissance (ISR) satellites. They also offer unclassified imagery, allow government ISR satellites to focus on critical targets, and provide timely supplements to government satellite imagery. NGA has bought high-resolution imagery of hundreds of millions of square kilometers and is planning to expand commercial imagery purchases as part of a broader strategy to meet U.S. national security imagery needs.[12] Significantly, commercial imagery is now part of the formal national security imagery architecture.

Beyond communications and imagery, the DoD is considering placing a broader range of payloads on commercial satellites. These could support almost the full range of space missions, including positioning, navigation, and timing; weather and environmental monitoring; communications; or ISR.

DoD's reliance on the commercial space sector, already extensive, is very likely to continue to grow. The *Space Posture Review: Interim Report*, issued in March 2010, makes clear that DoD and the intelligence community are interested in making substantial use of commercial space capabilities in the future, and the report clearly illustrates that demand for bandwidth is only projected to increase.[13] With continued overseas operations that rely critically on imagery and communications, national security reliance on space-based capabilities has become "pervasive, sophisticated, and important."[14] The same will be increasingly so for commercial space capabilities.

C. Though never before explicitly stated, assured and secure access to space for key commercial assets is also a national security imperative.

CSIS concludes that the dependency of our national security on commercial assets in space merits consideration of an assured access policy for key parts of the commercial space sector. Assured access is defined as "a sufficiently robust, responsive, and resilient capability to allow continued space operations, consistent with risk management and affordability."[15]

The conclusion that assured access to space also applies to commercial assets was not fully embraced in the most recent "U.S. Space Transportation Policy," issued by President George W.

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12. "Up Front: DNI Blair Announces Plan for the Next Generation of Electro-Optical Satellites," National Geospatial-Intelligence Agency, May 29, 2009. https://www1.nga.mil/Newsroom/Pathfinder/0703/Pages/UpFrontDNIBlairAnnouncesPlanfortheNextGenerationofElectro-OpticalSatellites.aspx; Jeff J. Leonard and Lynn Mueller, "Commercial Imagery Strategy Focused on End-User," Directions Magazine, November 8, 2007, http://www.directionsmag.com/article.php?article_id=2607.

13. Office of the Secretary of Defense and Office of the Director of National Intelligence, *Space Posture Review: Interim Report*, March 12, 2010.

14. Institute for Defense Analyses, *Leadership, Management, and Organization for National Security Space*, 3.

15. "NSPD-40 Fact Sheet: U.S. Space Transportation Policy," January 6, 2005, http://www.fas.org.irp/offdocs/nspd/nspd-40.pdf.

Bush on December 21, 2004. At that point, assured access was delineated as a requirement only for critical national security, homeland security, and civil missions. In fact, the past two decades of U.S. national space policies have consistently pointed out the connectivity between commercial space and national security. They stop short, however, of stating the next logical step: because commercial services are vital to national security, assuring commercial access to space in order to ensure provision of those services is therefore a national security imperative. CSIS can find no official policy statement that explicitly conveys the U.S. policy of assured access to space to the commercial space sector.

Assuring access to space for critical commercial payloads involves a complex set of policy issues. In the past, assured access has meant access to U.S. launch providers and a robust U.S. launch industry. That remains a critical aspect of U.S. policy because of the importance of space services to U.S. national security, the sensitivity of U.S. national security space technology, and sensible caution in relying on other countries for space launch of assets critical to U.S. national security. Yet the commercial satellite industry today is distinctly international. Foreign companies manufacture, own, and operate satellites that provide services to a U.S. clientele, including the U.S. government, sometimes through wholly owned U.S. subsidiaries. These companies make their own choices concerning space launch services. For U.S. policymakers, assured access in this context means pursuing policies that allow the development of robust launch options at affordable prices for commercial satellite companies so that, ultimately, the United States has access to the critical payloads and services they provide.

D. Seven principal concerns regarding commercial access to space emerged from the CSIS review; these were bolstered by extensive interviews with experts in government, industry, and academia.

The United States relies more heavily on satellite services than any other country in the world, and U.S. national security is already highly dependent on commercial satellites. Dependence translates to vulnerability if access to these vital services can be interrupted, either in the short or long term. If no such vulnerability exists and none is foreseen, policymakers and decisionmakers have no cause for concern. Unfortunately, this does not appear to be the case. During CSIS interviews, senior leaders repeatedly raised several current and potential issues related to space launch services for commercial satellites:

D.1. Limited access to U.S. launch opportunities for commercial satellites. Commercial satellite launch customers face significant challenges in getting manifested at U.S. launch ranges and, when they are manifested, in holding a reliable launch date. Despite national policy guidance, domestic launch services have become effectively inaccessible to commercial satellites owing in large part to these scheduling challenges.[16] National Security Presidential Directive (NSPD) 40, "U.S. Space Transportation Policy," issued on January 6, 2005, recognizes the importance of a healthy commercial space launch industry in supporting U.S. economic interests, yet launches of government payloads completely dominate the United Launch Alliance (ULA) manifest through 2012.

16. While many interviewees expressed frustration with the inaccessibility of ULA for launching commercial payloads, the Air Force officially recognizes this concern; see "Enabling Concept for AFSPC EELV Launch Scheduling and Forecasting Process," Air Force Space Command, December 23, 2009.

ULA has supported the launch of only two geosynchronous commercial satellites in the past four years, and no commercial launches are scheduled through 2012. Neither ULA nor the government appears resolute about providing better access for commercial satellite launch customers.

D.2. Potentially uncertain access to international launch providers. Geopolitical climates shift, which could potentially threaten access to international launch providers. The U.S. government has authorized launches of satellites with U.S. content by Arianespace (a European space launch company based in France) and International Launch Services (ILS, a U.S.-based company that markets the Russian-built Proton launch vehicle) that would otherwise be prohibited. International launch providers have always been willing to launch U.S. content satellites. In the future, however, neither the authorization to launch nor unrestricted access to foreign providers is guaranteed.

D.3. Fragile U.S. launch industrial base. Many government and industry sources have raised deep concerns related to the space industrial base. These concerns include the consequences of industry consolidation, weakness in the second and third tiers of the industrial base, the ability to attract qualified suppliers, reliance on foreign suppliers, and the ability of industry to attract and retain a qualified workforce.[17] Both the national security space sector and the commercial space sector leverage the U.S. industrial base. To the extent that the industrial base is decaying and calling into question the U.S. ability to put payloads on orbit, this is a national security concern.

D.4. High and increasing launch prices for government and commercial satellites. The price of launch has increased significantly during the past three to five years for both government and commercial satellites.[18] This is true for both U.S. and foreign launch vendors. Because launch prices are not made public, the question of how much that price has increased is a matter of some disagreement among observers. Some estimate that it has increased by more than 50 percent, others judge it to be somewhat less, but all observers agreed that prices have risen. Causes for that growth are hard to pin down.[19] Rising launch prices have been attributed to depletion of inventory, a lower number of launches annually, artificially low launch prices earlier in the decade, reduced competition, and (in the United States) a deteriorating second- and third-tier industrial base.[20]

D.5. Payload security, including hosted payloads. While many observers suggested that payload security for overseas launches has become quite good, others noted past problems and that the

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17. See, for example: Office of Science and Technology Policy, Executive Office of the President, "Report to Congress on the Space Launch Industrial Base," December 22, 2009, http://www.whitehouse.gov/files/documents/ostp/press_release_files/OSTP%20Letter%20on%20Space%20Launch%20Propulsion-12%2022%2009.pdf.

18. The cost of a launch and the price of a launch are two different things and should not be confused. The price is what a customer pays for launch; the cost is how much money the vendor spends to launch. It is quite possible that the actual cost of accessing space could decrease, but the price paid to access space would not reflect this. The price of launch can also be assessed in different ways, including price per launch, price per kilogram of payload launched, and price per unit of payload capability launched. As rockets have gotten larger, they have gotten more expensive, and the price of launch reflects that increase. On the other hand, larger rockets have larger payloads, and payloads often become more effective per kilogram over time—for example, in satellite communications, transponders can handle much higher data rates today than they could 10 years ago.

19. Henry R. Hertzfeld and Nicolas Peter, "Developing New Launch Vehicle Technology: The Case for Multinational Private Sector Cooperation," *Space Policy* 23, no. 2 (May 2007), 81–89.

20. See, for example: Gary E. Payton, "Military Space Programs in Review of the Defense Authorization Request for Fiscal Year 2011 and the Future Years Defense Program" (testimony before the Armed Services Committee, Strategic Forces Subcommittee, House of Representatives, April 21, 2010).

security of commercial payloads critical to national security remains a serious issue. CSIS found no study verifying foreign intrusion of a satellite payload prior to launch by a foreign provider in the past decade. Alternatively, the shift to hosted payloads—putting sensitive military, civil, or intelligence payloads on commercial satellites—might increase the potential for intrusion simply because hosted payloads are higher-value targets and require greater security.

D.6. Potential grounding of a class of launchers should there be a catastrophic event. Launching satellites is a complex enterprise, relying on unique equipment and infrastructure. Disruption of launch services due to a catastrophic event is a constant concern. An unprecedented string of launch failures from 1984 to 1987, including the Challenger shuttle disaster, led to a general suspension of all major U.S. launch vehicles until root causes could be determined. Flight operations for Atlas and Delta resumed after several months, but Titan was grounded for a year and a half, and the shuttle resumed operations only after a suspension of 32 months. Today, the U.S. launch industry provides two medium to heavy launch vehicles, the Atlas V and the Delta IV. Catastrophic failure of either could lead to an extended grounding and a reliance on only one launch vehicle; catastrophic failures of both types of launch vehicles—historically not an implausible event—could ground the entire U.S. launch fleet. Similarly, the majority of commercial geosynchronous orbit launches today are accomplished by only two foreign launch providers—ILS and Arianespace. A third launch provider, the China Great Wall Industry Corporation (CGWIC) is capable of launching medium-lift satellites to geosynchronous orbit, but this option has not been used by a U.S. provider in more than a decade. A failure of either ILS or Arianespace could leave commercial satellite launch consumers critically dependent on a single launch vendor for an extended period, facing the prospect of monopolistic pricing and a shortage of launch capacity to meet their needs.

D.7. Long-term implications for U.S. national security if current plans and policies are not changed. Many interviewees expressed the concern that the United States lacks a consistent, comprehensive national space policy or an executable strategy that would provide the basis for continued U.S. leadership in space. In the absence of such a policy and executable strategy, U.S. leadership may wane, with serious consequences for both the U.S. economy and U.S. national security. While reflecting on the lack of a coherent U.S. national space policy, the same individuals were also quick to note the growing internationalization of space. During the past 50 years, the United States has been the technological and commercial world leader in space, but the landscape has changed. Companies in the United States are in direct competition with many foreign entities in virtually all areas of space enterprise: launch vehicles and services, remote sensing satellites, telecommunications satellites of all kinds (voice, direct TV, fixed and mobile services), and navigation services. The technological capability to build and operate sophisticated space equipment has spread worldwide.[21] While such competition per se is not necessarily a concern—the United States cannot prevent it in any event—what is of concern is the potential impact on the U.S. economy and national security if the United States fails to compete successfully and loses its leadership in space as a result.

21. Henry R. Hertzfeld, "Globalization, Commercial Space and Spacepower in the USA," *Space Policy* 23, no. 4 (2007), 210–220.

2 THE LAUNCH INDUSTRY TODAY

The state of today's space launch industry has been heavily influenced by non-market forces that have led to atypical market behavior.[1] These include U.S. space policies, the dominance of government customers for launch, the dominance of government in developing launch capabilities irrespective of demand, and government protection of space technologies. These dynamics help to shape the global environment in which space services are produced, including the U.S. and foreign launch industry; impact the cost and price of space launch; and ultimately affect commercial and government access to space—all areas of concern identified by CSIS in its research and interviews. An understanding of these factors will also be important in considering options to improve U.S. access to space. The dynamics are most relevant when examined in the context of U.S. national policy directives, demand expectations, and supply capacity.

A. U.S. space polices and directives have contributed to market uncertainties.

Several key documents establish policies that are significant to the launch industry. These include the U.S. National Space Policies of 2006 and 2010, the U.S. Space Transportation Policy, and the Commercial Space Launch Act. Although most of the policies embodied in these documents support the notion of expanding commercial launch options, not all of them have had a salutary impact on the launch industry or have provided better launch access for commercial satellites. In fact, most appear to have had a minimal impact, in part because they work toward varying and occasionally inconsistent goals.

Consistent with past policy, the U.S. National Space Policy of 2006 issued by President George W. Bush requires U.S. departments and agencies to use "commercial space capabilities and services to maximum practical extent"; to acquire commercial services when they are available and meet U.S. government needs; to increase private sector participation in the design and development of U.S. government space systems and infrastructure; and to ensure that U.S. government "space activities, technology, and infrastructure are made available for private use on a reimbursable, non-interference basis to the maximum practical extent, consistent with national security."[2]

On June 28, 2010, President Barack Obama released his National Space Policy.[3] While recognizing the growing international presence and demands in space, President Obama's space policy states that the United States remains the leading space-faring nation. His policy remains largely

1. Several interviewees contended that non-market forces (for example, the predominant influence of government in the launch industry) are so strong that space launch is not aptly described as a "market."

2. "U.S. National Space Policy," August 31, 2006, http://www.fas.org/irp/offdocs/nspd/space.pdf.

3. "National Space Policy of the United States of America," June 28, 2010, http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf

consistent with that of previous administrations. Many of his commercial space guidelines are almost verbatim those of President Bush. Like previous administrations, however, the policy was issued without an executable strategy, the absence of which may render accomplishment of the policy's goals problematic.

The National Space Policy could be interpreted as providing a robust basis on which to justify government actions to support commercial access to U.S. space launch infrastructure and to encourage the development of commercial space launch services. At the same time, the policy illustrates the inherent tension between government launch priorities and providing support for commercial launch. The DoD and the intelligence community have strongly prioritized government launches over commercial launches. This fits with the policy that such support for commercial launch is to be tendered on a noninterference basis consistent with national security requirements, but it has been implemented in a manner that does not promote new U.S. entrants into the launch market or provide commercial satellite launch consumers with predictable access to U.S. launch services. Such tensions might be resolved by the establishment of an executable space strategy, but such a strategy has never been established, nor does an adequate governance structure exist that could guide space activities and implement such a strategy.[4]

It is also worth noting that beyond the official presidential directives on space activities, many other social, technological, budget, political, and economic actions are decided by all three branches of the federal government. Some are related to space issues but are handled through other venues. Antitrust reviews, for example, performed by the Department of Justice and the Federal Trade Commission, often have far-reaching space implications if they deal with firms engaged in space activities.

The list of direct and tangential actions with an impact on space spans virtually the entire spectrum of government activities, from securities regulations to decisions from the courts. Many of these actions are taken for very valid purposes that are unrelated to space, but can work at cross-purposes to space policies prescribed in presidential directives. Alternatively, they may create incentives for other nations or companies in other nations to develop systems more aggressively in direct competition with U.S. capabilities. Taken collectively, these actions may make consistent execution of a U.S. national space policy very difficult. In addition, insofar as non-space policies and actions may have stimulated the development of robust space capabilities in other nations, they may have weakened U.S. economic leadership in space and diluted U.S. dominance in space technology, systems development, and space applications.

One prominent example involves U.S. export control policy. The 2006 U.S. National Space Policy states that "a robust science, technology, and industrial base is critical for U.S. space capabilities."[5] However, export controls create friction for U.S. companies competing in the global market and probably have had a significant adverse impact on the U.S. industrial and technological base. As a result of lack of access to foreign markets, the U.S. space industrial base has reported the loss of some $600 million per year, on average, between 2003 and 2006, and that money in turn feeds space development overseas in which the United States is not involved.[6]

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4. Committee for U.S. Space Leadership, "Memorandum for the President: America's Leadership in Space," March 10, 2009. In this white paper, the committee calls for such a strategy.

5. "U.S. National Space Policy," August 31, 2006.

6. Center for Strategic and International Studies, "Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls," February 19, 2008.

The U.S. Space Transportation Policy (NSPD 40) predates the 2006 National Space Policy, but it is entirely consistent with its focus on commercial services and support. It states that "the United States Government is committed to encouraging and facilitating a viable U.S. commercial space transportation industry that supports U.S. space transportation goals, benefits the U.S. economy, and is internationally competitive." But NSPD 40 also emphasizes the use of evolved expendable launch vehicles (EELVs) for U.S. government medium and heavy launches. Establishing a national launch capability as a strategic interest is neither unwise nor inconsistent with the practices of other space-faring nations. However, focusing on the importance of and reliance on the EELV has had a significant impact on commercial launch access in a manner that has tended to undermine the goals defined in NSPD 40.

First, this focus has contributed to a reliance on a single launch provider for U.S. government medium and heavy space launches. Support for two EELV launch providers during the 1990s and early 2000s was predicated on a launch market far larger than ever materialized. The collapse of the business case for low earth orbit communications networks left both Boeing and Lockheed Martin competing for far fewer launches than they had anticipated, and they ended up producing launch vehicles sooner than they were ultimately needed. Neither could remain profitable in the new, less robust launch market. This situation led to the establishment of the ULA, a business entity combining the Lockheed Martin and Boeing launch businesses. The merger was intended to ensure that the launch needs of the national security community would continue to be met; find efficiencies by combining business operations, manufacturing practices, and launch infrastructure of the two primary launch providers; and make certain that the new entity had enough business to sustain launch proficiency. Some observers believe that the establishment of ULA has resulted in significant savings, but ULA launch prices have risen in the past several years. Several interviewees voiced concern that a monopolistic, anticompetitive arrangement now exists between ULA and its potential customers.

Second, the emphasis on EELV within the Space Transportation Policy has created an anchor-tenant relationship between the U.S. government and ULA. ULA, by contract, provides launch services for government launches. The government prioritizes its own launches and allows commercial satellite launches only on a noninterference basis. ULA supports the Boeing and Lockheed Martin commercial launch companies when it is able, but many of those interviewed suggested that it has minimal incentive to provide support for commercial launch. This contention appears to be validated by the fact that ULA has supported only two commercial launches in the past four years.

In contrast with policies that have led to reliance on a single launch provider, the Commercial Space Launch Act (CSLA), first passed in 1984 and last amended in 2004, was intended to create a legal environment that would stimulate additional competitive launch providers to enter the market, facilitate investment in technology to enable enduring space access, and encourage further development of U.S. launch sites and launch support facilities. In the six years since the CSLA was last amended, one can conclude the following: the CSLA has failed to stimulate new private entrants into the commercial satellite launch market; DoD policies and actions with respect to encouraging commercial vendors to enter the market are ambiguous at best; and DoD planning and budgeting for new technologies that might encourage new entrants appears inadequate.

One key reason for the lack of new entrants into the launch market is that the technical, financial, and economic barriers to market entry are very high. The cost, complexity, and extended time frame related to the development of a new launch vehicle, the difficulty of dealing with

government regulations, the lack of access to government infrastructure, the lack of near-term return on investment, and uncertain prospects for long-term returns are serious disincentives to new potential market entrants.[7] The more benign legal environment established by the CSLA may simply be insufficient to overcome these barriers. Moreover, the recent amendments to the CSLA focus heavily on legal matters related to the growth of commercial manned flight (space tourism), a focus that has not benefited most of the commercial launch industry. The one new entrant into the launch market, Space Exploration Technologies (universally known as SpaceX), appears not to be motivated by the space tourism market. Another potential entrant, Virgin Galactic, is focused almost exclusively on space tourism, has not developed an orbital space vehicle, and is not positioned to be a significant launch provider in the commercial satellite market.[8]

One observer described DoD's policies and actions with respect to stimulating new market entrants as "schizophrenic." On the one hand, DoD encourages consolidation in the launch industry by its support of the ULA merger. On the other hand, DoD is also supporting market competition by encouraging SpaceX as an alternative to ULA. At the same time, both DoD planning and funding for research and development (R&D) for launch technologies, another path to supporting new entrants into the launch market consistent with CSLA goals, appear inadequate. DoD has no technology or system road map for current and future launch needs. Such a road map would provide a guide for industry investment, provide a time line for new entrant integration into the market, and could improve the efficiency of systems needed for access today. Past initiatives, such as the 2001 Space Launch Initiative and the 2002 Operational Responsive Spacelift Initiative, foundered and were either cancelled outright or withered away. Today DoD has multiple pockets of minimal funding for disparate and seemingly unlinked propulsion technologies.

B. Demand for launch services appears unrelated to price and reliability, the primary criteria on which launch contracts are awarded.

Launch demand has been relatively flat for several years and is expected to remain so for the foreseeable future. Trends in launch demand, however, seem to have little correlation with factors that customers of space launch value from a launch provider. In other words, improvements on the supply side of the economic equation may be unlikely to generate additional demand for launch.

A brief review of launch trends compared with launch price suggests rather strongly that factors other than price dominate the launch demand equation. Launch prices were fairly constant from 1993 to about 2000, but launches fluctuated from a peak of 23 in 1996 to a valley of 12 or 13 in 2001, as prices were falling. Prices fell through 2003 or 2004 as the number of launches fell, and

7. "Barriers to Entry and Sustainability in the US Space Industry," National Security Space Office, February 2008, http://www.acq.osd.mil/nsso/industrialBase/Barriers%20Survey%2020Feb08.pdf.

8. A foreign investor in Virgin Galactic tentatively committed to developing the capability to launch small payloads into orbit, but that development seems not to have begun yet. See Issac John, "Virgin, Abu Dhabi's Aabar Set for Spaceship Flight in 2011," *Khaleej Times* (MENAFN), April 3, 2010, http://www.menafn.com/qn_news_story_s.asp?StoryId=1093310682&src=MOEN, and "News – Galactic Announces Partnership," Virgin Galactic, July 28, 2009, http://www.virgingalactic.com/news/item/galactic-anounces-partnership/.

launches increased in 2007, as prices increased. The impact of price on demand would seem to be unclear, at best.[9]

Launch prices may be a secondary factor for U.S. government launch consumers, who above all else value launch reliability. This relates directly to the cost of launch failure to the government. This cost is most significantly operational: because of the fragile state of many U.S. national security satellite constellations, a launch failure could result in a critical gap in capability. The cost is also in part economic—military and intelligence satellites can be hugely expensive, so much so that the cost of launch is insignificant compared with the operational and financial cost of losing a satellite. Because government demand seems related to the capabilities provided by the satellite, government demand for launch seems unlikely to increase if either launch reliability or price improves.

During CSIS interviews, commercial satellite launch customers affirmed three factors that guide their decisions about sourcing space launch, all related to the profit potential of payloads. These factors, in order of priority, are launch price, technical reliability, and schedule reliability. Lower launch price improves the corporate bottom line and competitiveness. Technical reliability reduces the chance of a lost satellite and lost revenue stream, and launch schedule delays in turn delay revenue streams. Here again, however, improvements in these factors by a launch provider may impact the decisions about which launch provider to use, but they seem unlikely to generate additional demand.

Overall launch demand appears to be most closely related to growth in national security and commercial applications in space, that is, the capabilities (or income stream) provided by satellites. The significance of these factors appears to outweigh launch costs and reliability. Although national security requirements for space-based capabilities continue to grow, this has generally translated into deployment of more capable satellites in small constellations. Incremental capability has been added largely by increasing satellite size and using more advanced technology rather than increasing the number of satellites. Launch demand has been further suppressed by extending the design life of satellites, reducing the need to replace them as often. In a sense, the launch industry is caught in a loop—because launch is expensive, the government generally opts for fewer, long-lived, very capable satellites.[10] This in turn limits launch rates, which keeps launch costs and prices relatively high, and generates demands for additional expenditures to enhance mission assurance out of the fear of losing an expensive satellite.

Commercial applications, particularly in communications, have also grown at a rapid rate, but this growth has not generated demand for a larger number of launches. Again, the increased demand for communications services has been met, principally by larger, heavier, more capable satellites. This tendency toward larger satellites has increased demand for mass launched per year, which has grown steadily. Since 1994, average mass per satellite has grown from 2,300 kg to 4,350 kg, and annual demand likewise has almost doubled from 53,000 kg to 103,000 kg. The annual

9. "Space Transportation Costs: Trends in Price per Pound to Orbit 1990–2000," Futron Corporation, September 6, 2002; FAA Commercial Space Transportation and Commercial Space Transportation Advisory Committee, *2010 Commercial Space Transportation Forecast*, May 2010, 2.

10. Col. Jim Nugent, deputy division chief for responsive space at Air Force Space Command, says that the traditionally high cost of launch has led the Air Force to focus on "very capable and high density satellites that are more expensive and longer-lived. These payloads don't require frequent launches." See Breanne Wagner, "Market Slow-Down: Low Cost Space Launch Vehicles Await Lift-Off," *National Defense*, June 1, 2008, http://www.thefreelibrary.com/Market+slowdown:+low-cost+space+launch+vehicles+await+liftoff-a0180028720.

number of launches is about the same as in 1994, however, and is expected to remain about the same for the next 10 years.[11]

C. Dynamic supply capacity has created and continues to create unstable, unpredictable, and inefficient cost and price pressures.

The factors associated with supply capacity have created and will continue to create unstable, unpredictable, and inefficient price and cost dynamics. The two dynamics with the greatest impact are new, non-market entrants to the supply and U.S. government purchasing practices.

U.S., Russian, European, and Chinese launch providers (Boeing and Lockheed supported by ULA, ILS, Arianespace, and CGWIC, respectively) have sufficient manufacturing capacity to meet expected global, regional, and U.S. launch needs. Beyond these suppliers, one commercial company, SpaceX, is entering the launch market, and another, Sea Launch, is trying to reenter the market after its expected emergence from bankruptcy.[12] Other nations including Japan, India, and South Korea are also developing and deploying launch capability. Launch capabilities are generally developed by nations, not companies, and are developed for fundamentally national rather than commercial reasons (such as assured access to space capabilities, avoiding reliance on foreign nations for space transportation needs, driving economic growth and technological progress, and national pride). Some launch capabilities are operated by governments with little attention to cost. Some are produced by state-created and -owned corporations, for which government influences or subsidies are difficult to assess.[13] These motivations lead to a global excess in space launch manufacturing capability and skewed pricing for commercial launches.

As more non-market-driven launch providers offer launch services, excess capacity can create diverging cost and price pressures. Additional capacity from non-market players will create downward price pressures. As individual government subsidies from those interested in establishing national or regional capabilities increase, that downward pressure will continue to mount. However, previous investment in fixed-launch infrastructure will actually create an upward cost pressure. With more providers and constant launch demand, launch providers would have to amortize fixed costs over fewer launches. These costs may either be passed to the satellite customer or subsidized by interested governments. This phenomenon has been present during the last decade and a half as supply has outstripped demand and commercial launch vendors have suffered.

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11. FAA, *2010 Commercial Space Transportation Forecast*, 2.

12. Stephen Clark, "Sea Launch Prepares to Reorganize after Bankruptcy," *Spaceflight Now*, May 14, 2010, http://spaceflightnow.com/news/n1005/14sealaunch/. The reorganization plan must still be approved by a U.S. court. Sea Launch's emergence from bankruptcy is reportedly being financed by Energia Overseas Limited (a subsidiary of the Russian company S. P. Korolev Rocket and Space Corporation Energia), which will acquire 85 percent of Sea Launch stock. According to Energia's home page (http://www.energia.ru/english/), 38 percent of Energia stock is owned by the Russian government.

13. For example, CGWIC, which makes and launches Long March launch vehicles, is a state-owned corporation; and the Khrunichev State Research and Production Space Center, which produces launch vehicles for ILS, is a Russian federal state unitary enterprise, a corporation set up by the Russian government to meet Russian government goals. See the Krunichev Web site (in Russian, at http://www.khrunichev.ru/main.php?id=33.

Concerning U.S. supply, the U.S. government is the largest customer of U.S.-provided launch vehicles. Although U.S. government launch demand is relatively stable, the government buys launch services for individual launches, and procurement practices prevent the government from block purchases of launch vehicles, as would be the practice in a commercially driven market. Thus, ULA cannot anticipate government demand and cannot plan production or order components from its subtier contractors effectively. Consequently, launch vehicle production is inefficient and the cost of production is high compared with what it might be in support of a commercial market. Foreign providers buy launch vehicles based on multiyear projections, reaping significant savings and making them more cost competitive in the commercial market. Some experts estimate that inefficiency in U.S. production adds a 30 to 40 percent premium to U.S. launch costs; this premium clearly hurts the competitiveness of U.S. launch in the commercial launch market. Other experts have noted, however, that in light of its dependence on U.S. government launches, there may be financial incentives for the U.S. industry in these inefficient practices because its profits are based on a percentage of the total cost.

Another impact of the dominance of non-market influences on supply is the apparent inability to determine launch costs accurately. Whereas commercial entities are strongly concerned with and influenced by efficiency (a function of service and cost), governments tend to be more impressed by effectiveness (a function of mission success) and the cost of achieving effectiveness is less of a factor. Calculation of costs in any government enterprise is often problematic, and understanding actual space launch costs is often of secondary importance to mission success and sustaining a capability necessary for national security and other noncommercial reasons. All launch services are subsidized, and government assistance and subsidies used to sustain launch enterprises further cloud the cost picture. Some interviewed by CSIS noted that the ULA contract structure intertwines infrastructure (owned and sustained by the government) and marginal costs so thoroughly that understanding the ULA cost structure is problematic. Others suggested that ILS and Sea Launch may have had similar difficulties in accurately assessing their own costs. In the absence of accurate cost data, launch pricing can be either arbitrary or simply inaccurate. This may have been a contributing factor in launch prices earlier in this decade: those prices may have been artificially low simply because providers did not understand their own costs.

C.1. Lack of reliable access to launch suppliers effectively reduces launch supply. While manufacturing capacity of launch vehicles may be ample, commercial satellite launch customers have a limited range of launch options available. Commercial access to U.S. and Chinese launch services are constrained, leaving Arianespace and ILS as the principal options. In the future, Sea Launch may be a viable option if it emerges from bankruptcy successfully. SpaceX, with the recent successful launch of a Falcon 9 medium-launch vehicle, may also become a viable option—in the long-term, but not now or in the near future.

U.S. launch vehicles have an extraordinary record of reliability during the past decade. This has resulted in part from the national security community's priority on and continued investment in mission assurance. Not surprisingly, given the dominance of the U.S. government as a launch customer and the U.S. government's focus on mission assurance, the systems and processes for U.S. launch range and operations have been primarily developed around government requirements and culture. Many believe that this has reduced access to launch ranges and added schedule risk for commercial launch customers.

These effects can be seen in launch scheduling, the current practice of which often prevents commercial entities from establishing reliable launch dates. The DoD now reserves a launch slot

with ULA 30 to 36 months before the launch is scheduled. Typical commercial customers place launch reservations 24 months ahead of the anticipated launch date. Thus, ULA is fully booked for the next three years with government launches, and commercial customers seeking a launch slot are shut out. DoD launches are often delayed, but program offices often release those launch slots very late—a few months before the scheduled launch—thus not allowing commercial customers to take advantage of the newly opened launch slot and leaving valuable launch opportunities unused. As government launch needs change, ULA is provided incentives to meet those changing needs before it meets the needs of any commercial customer. DoD also tends to view specific launch vehicles as committed to a specific DoD launch; when program delays occur, those specific launch vehicles are often not released for commercial use. Finally, commercial launches have sometimes lost launch slots because launch schedules for higher-priority government payloads changed.

As a consequence, commercial satellite launch consumers currently have little confidence in their access to U.S. launch or in their ability to hold launch dates even if manifested. Several senior leaders among commercial launch customers and launch providers contend that government and ULA credibility with commercial launch customers is very low. Some suggest that neither the government nor ULA has much incentive to change their practices. Accommodating commercial satellite launches may detract from DoD's focus on and ULA's support of mission assurance, and some interviewees maintain that the government-ULA contract provides disincentives for ULA to support commercial launches.[14] The lack of structured, constructive dialogue between commercial operators and DoD launch range operators makes addressing some of these problems difficult.

Access to Chinese launch is restricted by U.S. policy. For example, the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991 suspended the export of satellites for launch by China; importantly, however, this law also included an option to terminate, or waive, such a suspension for individual launches, provided that the president report to Congress that it is in the U.S. national security interest to do so.[15] Former presidents used this waiver authority several times between 1990 and 1996, but such waiver authority for launching in China has not been used since the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 was enacted. More broadly, in 1998, U.S. law placed satellites on the U.S. Munitions List under the control of the Arms Export Control Act.[16] Thus, the launch of satellites containing U.S. technologies by foreign launchers is prohibited unless the U.S. government authorizes it.

These measures are intended to protect U.S. advantages in sensitive space technologies and protect U.S. national security. While the government has consistently provided such authorization for ILS and Arianespace, it has not allowed satellite launches with U.S. technologies in China. This situation stems from an incident in 1996 in which two U.S. companies, Loral Space & Communications, Ltd., and Hughes Electronics, provided assistance without an export license to China to help determine the cause of a Chinese launch failure. Many contend that this assistance helped China improve its military capabilities. Since then, some believe the U.S. refusal to authorize launches in China has become subject to a variety of political (national economic and foreign

14. CSIS has not reviewed this contract.

15. *Foreign Relations Authorization Act for Fiscal Years 1990 and 1991*, Public Law 101-246. When the president waives the export control restrictions, he is in legal and statutory terms terminating the suspension of export controls. In this paper, for clarity and consistency, CSIS uses the term "waive" in reference to this specific legislation to represent the action of terminating the suspension of satellite exports for launch by China.

16. *Strom Thurmond National Defense Authorization Act for Fiscal Year 1999*, Public Law 105-261.

policy) considerations unrelated to protection of U.S. technology. For more than a decade, commercial satellites with U.S. content have not been launched from China, further restricting launch options open to commercial launch customers. During this time frame, CGWIC has demonstrated capacity to launch medium-lift payloads, touting on its Web site 75 successful launches since October 1996.[17]

Not all access to foreign launch has faced such severe challenges. Arianespace is owned by 24 entities from 10 European countries, 8 of which are NATO allies, and its business base from inception has been the launch of commercial satellites. The security plan at the European Spaceport in Kourou (on the coast of French Guiana) has been reviewed by DoD's Defense Technology Security Administration, and Arianespace is considered to be a NATO launcher under the U.S. government's International Traffic in Arms Regulations (ITAR). The circumstances under which Arianespace might deny launches to the United States are difficult to imagine.[18]

Likewise, ILS has been a reliable launch provider. This has been the case throughout ILS's history, and the United States has never denied a license to launch satellites with U.S. content on ILS launch vehicles. Overall U.S.-Russian relations have improved greatly since the end of the Cold War, but these relations have not always been smooth. Russia frequently has interests at odds with those of the United States, and the circumstances under which Russian support for U.S. commercial satellite launch might wane, while unlikely, are more plausible.[19]

Recent industrial analyses confirm the practical impact of limited access to launch suppliers. Extrapolated historical levels of demand from 2010 to 2018 for 21–22 launches a year have not been met by the recent demonstrated Ariane 5 and Proton annual launches—a problem that could be exacerbated by spikes in demand. Such spikes are not unusual (see Figure A). Additional launch providers (for example, Sea Launch, Atlas V, Delta IV, or others) could meet the demand, but access to these providers has been difficult at best. Figure A clearly shows the brittleness in the current launch market and points out the magnified risk posed by the potential failure of one of the two current launch vehicles.[20]

C.2. The risks of catastrophic events are low but cannot be ignored. Another risk to supply relates to the potential for catastrophic events that affect space launch, including the potential for natural (or man-made) disaster at launch sites and the consequences of failure of rockets to launch.

The risk of natural disaster at launch sites is probably highest at Kennedy Space Center in Florida because of its low elevation, proximity to the coast, and the fact that its position on the Atlantic

17. "Launch Record: Long March Launch Record," China Great Wall Industry Corporation, April 1, 2010, http://www.cgwic.com/LaunchServices/LaunchRecord/LongMarch.html.

18. 60 percent of Arianespace is owned by French entities; the French government's space agency owns about one-third of the company by itself; see "Corporate Information," Arianespace, http://www.arianespace.com/about-us-corporate-information/shareholders.asp. Although French government influence on Arianespace might be debatable and French foreign policy has often been quite independent, the company's business orientation, history, and multiple ownership suggest that future difficulties are unlikely.

19. As an example of competing interests, Russia is thought by some to have been involved in cyber attacks on Estonia and Georgia (both U.S. allies) and the Pentagon; see Alex Spillius, "Russian Hackers Penetrate Pentagon Computer System in Cyber Attack," *UK Telegraph*, November 30, 2008, http://www.telegraph.co.uk/news/worldnews/northamerica/usa/3535165/Russian-hackers-penetrate-Pentagon-computer-system-in-cyber-attack.html.

20. "Study of Commercial GEO Launch Services Price Trends Over Ten Years"

Coast is in a common track for hurricanes. The Arianespace launch site at Kourou, French Guiana, is further inland at a slightly higher elevation and is not on a hurricane track. Russian launch sites (Baikonur, Kapustin Yar, Plesetsk) are inland and not subject to severe weather (other than harsh winters). None of the sites is an area considered to be geologically active. The probability of a distant geologic event (for example, an earthquake, volcano, or tsunami) impacting any of the major launch sites is quite low. Although the probability of loss of any of the major launch facilities is probably low, the consequences for the overall structure of the space launch environment would likely be very considerable—a good argument for diversity.

A catastrophic launch failure (or series of failures) could lead to an extended period during which one or more types of rockets are grounded while the cause of the failure is being determined and fixed. During such a period, launch consumers would be more restricted in their launch options and could be subject to higher launch prices in the absence of viable alternatives. This sort of grounding has occurred once in the past, following a series of launch failures in the mid 1980s that included the destruction of the space shuttle Challenger. More recently, launch failures among more mature launch vehicles are regular but relatively uncommon events. Several observers strongly suggested that the history of the launch industry does not support a concern today about extended groundings. Recent history suggests that in the wake of a launch failure of a mature space launch vehicle, operations could resume in a matter of several months since the technology of a mature launch vehicle—and presumably its failure modes—is well understood.

Failures of this sort, however, are still taken very seriously. The dominant U.S. rationale for supporting two launch vendors was assured access to space—and a single launch vendor was deemed inadequate because of the risk of launch failure. Commercial launch consumers sometimes take the step of protecting themselves by making arrangements for a launch alternative if the anticipated ride into space is not available. Although the risk of extended grounding is low, it is not discounted by launch consumers.

D. Space capabilities of other nations are increasing and U.S. leadership in space is eroding.

Policies, prescriptions, and economics have consequences. In short, U.S. policies and practices have for many years tended to push commercial satellite launch consumers to foreign launch providers. Other U.S. policies have inhibited the launch of satellites with U.S. content on foreign launchers. This in turn has probably encouraged the growth of foreign satellite manufacturing and restricted the ability of some U.S. industries to access foreign technology. All of these trends have eroded U.S. leadership and weakened U.S. competitiveness. At least partly because of past U.S. decisions, the current global space industrial landscape now includes rapidly emerging foreign space capabilities, and the United States does not control their proliferation. As other nations achieve greater independence in space technologies and space launch, U.S. leadership in space no longer is guaranteed—and some argue that it is already lost. Such competition may well have been inevitable as other nations seek to address their own economic and security needs, but U.S. policies and actions may have contributed to the erosion of U.S. leadership and at the very least may inhibit efforts to reestablish a more robust U.S. space launch industry.

The trend toward foreign competition may be reaching a critical juncture. Brett Lambert, director of industrial policy in the office of the Under Secretary of Defense for Acquisition,

International Traffic in Arms Regulations (ITAR) Restrictions

ITAR is a particularly significant topic among international interlocutors, who argue that these regulations are unnecessarily restrictive and time-consuming as well as counterproductive as they promote foreign nation technology development and dissemination to the detriment of U.S. suppliers. U.S. executive branch agencies generally agree that ITAR, as a whole, is ripe for reform, noting that several nations that are close military and trading partners—for example, the United Kingdom and Canada—have sought ITAR waivers for years. A 2007 State Department report prepared by the International Security Advisory Board (ISAB) states:

> The current International Traffic in Arms Regulations (ITAR) list is too broad. It includes too much technology that is widely available internationally. Moreover, a single international transaction involving commercial space technology now often requires multiple licenses. Licenses often come with extensive restrictions that make resubmission necessary, causing further delay and uncertainty for U.S. manufacturers in the commercial international market place.[1]

Solutions proposed by ISAB are to review the ITAR list, regulate only key technologies and exporters, and issue broad licenses to streamline the process.[2]

Scientists are expressing their concern about the restrictions imposed by the U.S. export control regime. Nobel laureate George F. Smoot noted: "Collaboration between U.S. and European scientists is harder now than it was before U.S. technology-transfer rules were tightened in 1999 . . . U.S. government officials charged with reviewing bilateral or multilateral science projects have been so worried about being accused of letting sensitive technologies slip into the wrong hands that they have overcompensated.[3] William Gerstenmaier, NASA's associate administrator for space operations, put

Technology and Logistics, recently argued that European and Asian countries developed space industries because they have not had access to U.S. technology: "We're at a tipping point with our space industry . . . we have for so long been the dominant player and the most technologically advanced player . . . [but] as they get more capable, we will become less competitive."[21]

D.1. U.S. export control policy has probably encouraged the growth of foreign space capabilities. As noted previously, nations develop space capabilities for a variety of reasons. U.S. export control policies have long been a matter of controversy, but the consensus among those interviewed by CSIS is that these policies continue to be a significant driver in the evolution of space capabilities, markets, and industrial capabilities. As the ITAR are applied to space technologies, the launch of satellites with U.S. technology content by foreign launch providers is prohibited unless the U.S. government reviews the technology involved and authorizes such a launch. The purpose of this restriction is to protect against the transfer of sensitive satellite technology to foreign countries, with the twin goals of protecting U.S. advantages in space technology and preventing the use

21. Antonie Boessenkool, "DoD: U.S. Space Industry May Lose Edge," *Defense News*, May 25, 2010.

it more bluntly: "[Export controls cause] problems between us and our international partners that are really more of a problem than the benefit we are gaining by having the . . . restrictions in there."[4]

The International Space Station (ISS) Independent Safety Task Force reinforced this position in its final report:

> [A] contractor workforce comprises the majority of the [International Space Station's] operations workforce and must be able to have a direct interface with the [international partners] IP operations team to assure safe and successful operations. Their interactions and their ability to exchange and discuss technical data relevant to vehicle operations are severely hampered by the current ITAR restrictions. . . . Currently the ITAR restrictions and the IP's objections to signing technical assistance agreements are a threat to the safe and successful integration and operations of the Station.[5]

Notes

1. International Security Advisory Board, "Report on U.S. Space Policy" (Washington, D.C.: U.S. Department of State, 2007), 9, http://www.state.gov/documents/organization/85263.pdf.
2. Ibid.
3. Quoted in "Briefs," *Space News*, February 8, 2007, http://www.space.com/spacenews/archive07/briefs_0205.html.
4. Quoted in Brian Berger, "Export Rules Boost U.S. Civil Servant Role in ATV Mission," *Space News*, May 21, 2007, http://www.space.com/spacenews/070521_businessmonday_atv.html.
5. *Final Report of the International Space Station Independent Safety Task Force*, February 27, 2007, http://www.nasa.gov/pdf/170368main_IISTF_%20Final%20Report.pdf.

of this technology by U.S. adversaries to the detriment of U.S. national security. As mentioned earlier, the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991 suspends the "exports of any satellite of United States origin that is intended for launch from a launch vehicle owned by the People's Republic of China"[22] unless the president reports to the U.S. Congress that it is in the U.S. national security interest to waive that suspension for an individual launch. Thus, regardless of possible future export control modernization, the administration has existing legal authority to issue export authorizations for U.S. commercial satellite launches in China.

Expert opinion is divided about whether such restrictions enhance or inhibit U.S. national security capabilities, particularly given the global nature of the satellite market and the significant satellite and launch capabilities resident outside the United States. Some have maintained that when a nation launches rockets, military or commercial, its military capabilities are enhanced. Others contend that several commercial launches a year do little to enhance military capabilities. Some note that the United States has launched many payloads with foreign launch vendors and

22. *Foreign Relations Authorization Act for Fiscal Years 1990 and 1991*, § 902.

developed very robust security procedures to protect sensitive U.S. technologies. Others note the growing sophistication of foreign intelligence threats. Some believe that export controls have kept technologies that benefit U.S. national security out of foreign hands. Others have argued that other nations have developed their own technology base in response to U.S. export controls. In 2007, for example, the State Department's International Security Advisory Board issued a report stating:

> The Department of State should be prepared to facilitate international cooperation in the use of space through U.S. export policies. . . . While it is obviously essential to protect U.S. national security and space control, the current process damages U.S. cooperation with friends and allies and weakens the U.S. commercial space satellite industry and the underlying industrial base that develops civil, commercial, military, and intelligence space assets."[23]

Whether other nations would have developed new space technologies in the absence of U.S. export controls is moot. It is clear, however, that many countries have been undeterred by U.S. export control policy, and some have used those controls as a catalyst to develop indigenous space capabilities or engage in multinational collaboration with nations other than the United States. For example, China's decision several years ago to create various space communities stems in part from the fact China has been barred from launching satellites with U.S. components. By 2007, China had partnered with Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, and Thailand to develop an Earth observation satellite system; had organized a satellite association in Asia (the Asia Pacific Space Cooperation Organization); and had designed, built, and launched a communications satellite for Nigeria.[24] It also launched a Chinese-built communications satellite for Venezuela in 2008.

Europeans also view the U.S. export control regime as a catalyst for some of their space activities. Daniel Sacotte, head of the human spaceflight program of the European Space Agency (ESA), was quoted in 2005 as saying, "It's a shame, but it's not for me to comment on U.S. law, only to note its effects, and for the Rover [the U.S. Mars probe], ITAR would have made cooperation too complicated to be feasible. . . . We are now obliged to develop our autonomy in various areas, which is no bad thing. . . . We may also find partners besides NASA."[25] In line with this announcement, the ESA is funding the development of a European supplier of solenoid valves in order to remove that U.S. part from European space propulsion systems. The Spanish company CASA developed its own capability to supply reflectors as part of the European ITAR-free space technology movement (it previously had limited capability), and today it is a global competitor in reflectors technology.

Similarly, Indian prime minister Manmohan Singh proudly announced to the Indian Space Research Organization (ISRO): "It is a matter of particular pride that international technology denial regimes have not impeded your efforts—in fact, they have spurred you to greater heights."[26]

D.2. U.S. policies may inhibit business opportunities for U.S. companies. U.S. companies also believe that export controls make penetration of foreign markets more difficult. As demonstrated

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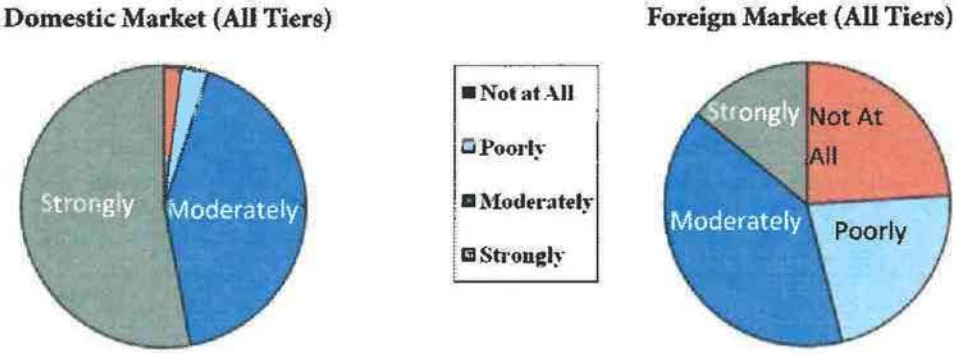
23. International Security Advisory Board, "Report on U.S. Space Policy" (Washington, D.C.: U.S. Department of State, 2007), 9, http://www.state.gov/documents/organization/85263.pdf.

24. Jim Yardley, "Snubbed by U.S., China Finds New Space Partners," *New York Times*, May 24, 2007, http://www.nytimes.com/2007/05/24/world/asia/24satellite.html.

25. Quoted in Jason A. Crook, "National Insecurity: ITAR and the Technological Impairment of U.S. National Space Policy," *Journal of Air Law and Commerce*, no. 74 (Summer 2009).

26. "Space India–Newsletter," Indian Space Research Organization, September 21, 2005, http://www.isro.org/newsletters/spaceindia/julsep2005/Chapter6.htm.

Figure 2.1. Company Perspectives on Being Competitive in Domestic and Foreign Markets (All Tiers)



Source: Air Force Research Laboratory analysis of survey of 202 space companies and business units, 2007.

by the responses of U.S. space executives to a survey conducted by Booz Allen Hamilton in 2006,[27] U.S. companies are frustrated by the uncertainty involved in complying with ITAR. Fifty-six percent of respondents disagreed or strongly disagreed with the statement that export controls are easy to understand, 71 percent disagreed or strongly disagreed with the statement that the time it takes to process an export control request is predictable, and 85 percent agreed or strongly agreed that this lack of clarity and unpredictability in the process hinders their ability to make strategic business decisions.

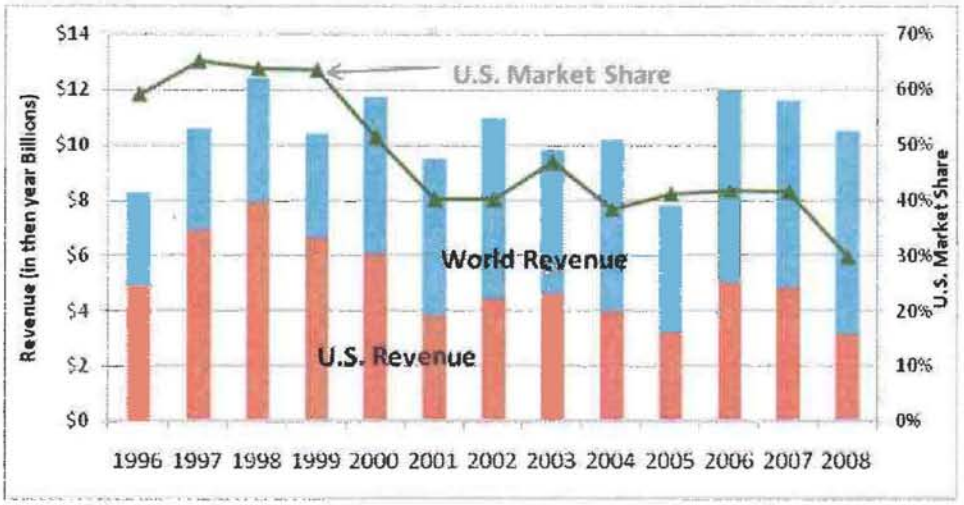
More recently, an Air Force Research Laboratory survey of U.S. space industry executives found that U.S. export controls affect the space industry's confidence concerning its ability to compete in foreign markets. Although the vast majority of U.S. companies are confident of their ability to successfully compete in the domestic market, close to 50 percent feel they are poorly or not at all equipped to compete in foreign markets (Figure 2.1).

D.3. U.S. dominance in space is eroding. Since the late 1990s, the U.S. share of both the global launch market and the global commercial satellite market has eroded significantly. A combination of factors described in this report, some within U.S. control and some not, has contributed to this erosion, including the high cost of U.S. systems, export controls, contradictory or poorly executed policy, and processes and practices that limited the use of U.S. systems and encouraged the growth of foreign capabilities. Many studies describe this decline. Data gathered by the Satellite Industry Association through 2009 reflect this trend (Figure 2.2) as does FAA space launch data (Figure 2.3).

Growing foreign space prowess can be seen across a full spectrum of capabilities. The United States was once dominant among very few space-faring nations, but today the number of nations active in space is much larger and continues to grow. Since 1999 the number of countries with indigenous positioning, navigation, and timing systems has tripled, and the number of countries with indigenous reconnaissance or earth observation satellites has doubled. A dozen countries are able to launch their own satellites, a number that continues to increase; and 38 countries have

27. Marty Bollinger and Joshua M. Boehm, "Moving toward a Faster and More Predictable Process of Licensing Defense Articles and Services for Export," Booz Allen Hamilton, 2006.

Figure 2.2. Revenue Breakdown and U.S. Market Share of Commercial and Government Satellite Manufacturing, 1996–2008



Source: Satellite Industry Association, *State of the Satellite Industry Reports*, 2005–2009.

operational control over their own communication satellites. Table 2.1 presents the growth in global space capabilities.

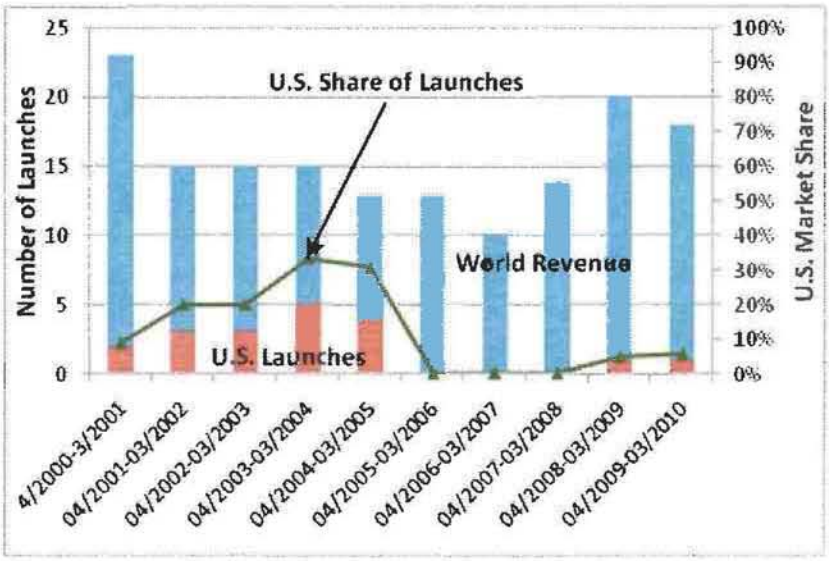
The increasing quality of foreign space assets is as important as their rising number. Russia, France, Israel, South Korea, and India, for example, all possess commercial imaging satellites capable of one-meter resolution or better. Canada, ESA, Italy, Germany, and Japan possess civil radar imaging satellites, and India and Argentina are positioned to join this group. China has launched two military radar imaging satellites, and Israel has launched one.

Although the United States clearly leads the rest of the world in military space capabilities, other nations, including U.S. allies, are developing similar capabilities. Several European countries, including France, Germany, and Italy, have developed dedicated military satellites for communications and earth imagery. The European Union, ESA, and other partners are developing the Galileo satellite navigation system to compete with the U.S. Global Positioning System (GPS).

In the global commercial communications satellite market, where the United States had a technical and qualitative lead over the international competition in the 1990s, global competitors have closed the gap in the last decade. Since 1998, European and Asian manufacturers of satellites have gone from delivering satellites that were smaller, had fewer transponders, and had less payload power and shorter lives to manufacturing satellites of equal weight, number of transponders, payload power, and lifespan. Figure 2.4 shows the declining U.S. dominance in the satellite market.[28]

28. *Defense Industrial Base Assessment: U.S. Space Industry Final Report,* U.S. Air Force and Space Industrial Base Council, August 31, 2007, http://www.bis.doc.gov/defenseindustrialbaseprograms/osies/defmarketresearchrpts/exportcontrolfinalreport08-31-07master___3---bis-net-link-version---101707-receipt-from-afrl.pdf.

Figure 2.3. U.S. Share of Commercial Geosynchronous Orbit Satellite Launches



Source: FAA data; CSIS Defense-Industrial Initiatives Group graph.

For commercial communications satellites, there is a clear trend away from buying U.S. satellites. In fact, officials in various European and Canadian organizations have specifically noted that they want to produce and procure "ITAR-free" space systems so as to avoid any dealings with U.S. export control regulations.[29] Examples of space technologies that are now touted as ITAR free include European apogee motors, thruster control valves and star trackers, and the Alcatel satellite bus.

D.4. The U.S. space industrial base is showing significant weaknesses as a result of the growth of foreign competition and weak demand. The U.S. space industrial base is largely dependent on U.S. government (primarily national security) budgets. U.S. government spending (both national security and civilian) on space systems in 2005 totaled $36.635 billion.[30] This represents 1.8 percent of the 2005 federal budget, or 0.3 percent of 2005 gross domestic product. However, within the U.S. space industrial base, the market share dominated by the U.S. defense and intelligence community customers is more akin to naval shipbuilding or tanks than to aerospace or other parts of the defense industry. About 60 percent of sales for first- and second-tier companies are to national security customers, and these numbers would be even higher if they included all government customers (that is, civilian government agencies such as the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration). This implies that the national security community today in effect "owns" the U.S. space manufacturing industry.

29. See, for example, Peter B. de Selding, "European Satellite Component Maker Says It Is Dropping U.S. Components Because Of ITAR," *Space News*, June 13, 2005, http://www.space.com/spacenews/archive05/Sodern_061305.html.

30. *Aeronautics and Space Report of the President: Fiscal Year 2005 Activities* (National Aeronautics and Space Administration, 2006), 101, http://history.nasa.gov/presrep2005.pdf.

Table 2.1: Growth in Global Space Capabilities, 1980–2025 (est.)

	Number of countries with specific capabilities				
Years	Launch own satellite(s)	Launched human spaceflight	Own positioning, navigation, timing system	Launched own reconnaissance or Earth observation satellite(s)	Control over own communications satellite(s)
1980	8	2	2	5	10
1999	11	2	2	14	32
2010	12[a]	3[b]	6[c]	27	38
Outlook					
2011–2025	Steady growth	India, European Space Agency, and Japan active	Full operationalization of European Union, Asian systems	Steady growth	Steady growth

Source: CSIS Defense-Industrial Initiatives Group data.

a Plus Iran.

b Plus China.

c Plus China, India, European Union, Japan.

The health of this industry thus depends on direct government support (akin to an "arsenal strategy") or policies that encourage and enable it to participate more effectively in the global marketplace in order to broaden its economic base. To date, the U.S. government has been unwilling to nationalize the industry, has not generated sufficient demand on its own to sustain competition (via multiple suppliers) in key technology niches, and has been unable to enforce or execute policies that provide for broader participation in the global market.

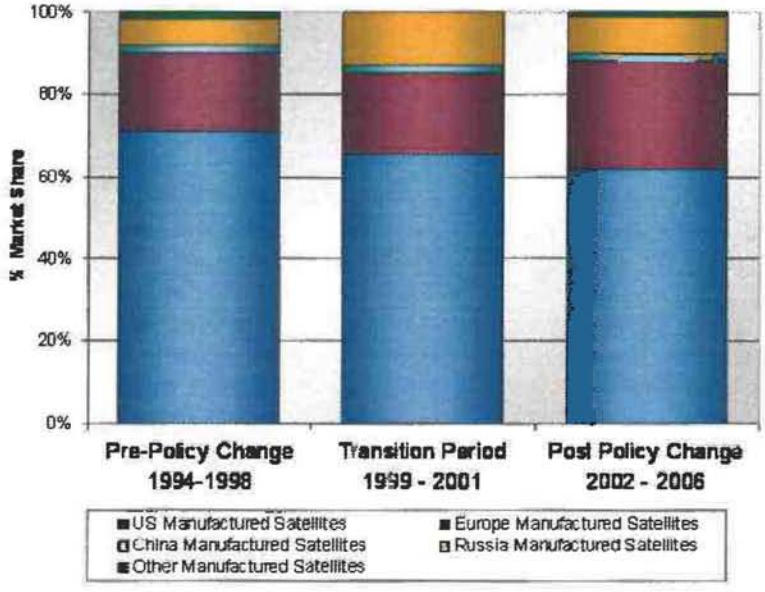
As a result, the United States has seen an extraordinary consolidation in its space industry.[31] The United States has one principal launch provider[32] and two principal satellite builders. The number of people employed today in the design and production of missiles and space vehicles is less than in 1990.[33] There are identified weaknesses in the second and third tiers of the U.S. space industry, areas in which only one domestic supplier exists. These weaknesses are particularly acute if that supplier is financially weak or if there are a small number of suppliers that are all financially weak. This is the case in critical areas such as lithium-ion batteries, solar cells (including solar cell substrates), traveling wave tubes, visual imagers, optical coatings, read-out integrated circuits, and infrared focal plane arrays. According to one report, within five years half of the current sub-

31. "Maintaining a healthy space industrial base is a matter of critical importance to our national security. In the history of the space age we have rarely been so reliant on so few space industry suppliers. Many suppliers are struggling to remain competitive as demand for highly specialized space components dwindles due to a niche government customer-base." Betty Sapp, "Statement for the Record," (testimony before the Armed Services Committee, Strategic Forces Subcommittee, House of Representatives, April 21, 2010).

32. Orbital (Taurus II, with a scheduled launch in 2011) and SpaceX (Falcon 9, which launched successfully for the first time on June 5, 2010) intend to compete in the medium to heavy launch market.

33. "Total Employment, Annual: Calendar Years 1990–2009," Aerospace Industries Association, Series 12, page 1, http://www.aia-aerospace.org/assets/stat12.pdf.

Figure 2.4. Share of Commercial Geosynchronous Orbit Communications Satellites, by Launch Period and Country of Manufacture



Source: Federal Aviation Administration, Office of Commercial Space Transportation, database, as reported by the U.S. Air Force, 2007.

Note: Policy changes referred to on this figure are the 1999 National Defense Authorization Act changes to ITAR.

contractors could exit the space business or cease to exist at all.[34] It is worth noting that healthy second and third tiers are important given the role they play in generating innovation. While the large primes spend about 1.5 to 2 percent of their revenues on internal research and development (IRAD), the second and third tiers spend between 5 and 15 percent of revenues on IRAD. Restrictions on competing in the global market result in fewer dollars available for IRAD.

There are also looming issues with the space-related workforce, particularly with the next generation of employees. The existing workforce is aging, a problem that is particularly acute among program managers, program directors, and system engineers. Having a workforce that has experience with many programs of varying characteristics is highly desirable for "growing" competence in these areas. Because the number of space programs has declined and the pace of development has slowed, the ability to generate the skills for those roles has diminished.

E. Conclusions

In addressing the reasons why decisionmakers should care about commercial access to space, CSIS concluded that commercial space is now critical to U.S. national security. Our research also

34. Jay DeFrank, "The National Security Space Industrial Base: Understanding and Addressing Concerns at the Sub-Prime Contractor Level," Space Foundation, 2007, http://www.spacefoundation.org/docs/The_National_Security_Space_Industrial_Base.pdf.

highlighted seven concerns raised by those we interviewed. Our findings largely validate these concerns:

- Commercial access to U.S. launch capabilities is clearly limited.
- U.S. policies have restricted access to foreign launch. Two foreign launchers, ILS and Arianespace, are predominant. Should policies in the United States or Russia shift, access could become more difficult or even narrower.
- Launch prices have increased during the past three to five years although the cause of those increases is not clear. Launch prices in the United States are much higher than prices for launches in foreign countries.
- The U.S. space industrial base is fragile. In the future, the U.S. industrial base may not be able to support critical U.S. military or commercial needs.
- Some experts believe that foreign launch of sensitive payloads constitutes a security risk; others disagree.
- Two foreign launchers provide most commercial geosynchronous satellite launches. Should either of the two launch systems suffer a failure, commercial launch would rely on a single system—a dangerous circumstance.
- Little in the execution of U.S. policy during the past decade provides confidence that negative trends will be corrected.

3 OPTION SETS TO BE ANALYZED FOR IMPROVING COMMERCIAL ACCESS TO SPACE

The heavy reliance of our military and intelligence communities on commercial space is now widely recognized, and a consensus is building that, as a recent Institute for Defense Analyses report stated, "a more strategic approach in planning for and employing commercial satellite capabilities" is needed.[1]

CSIS has concluded that assured access to space for these critical capabilities should be a matter of concern to U.S. decisionmakers, both because of the importance of these capabilities to U.S. economic and national security and because of concerns about current and potential problems related to commercial access to space that were widely expressed by experts interviewed by CSIS. An important aspect of CSIS's charter is to provide insight into policy solutions to those decisionmakers. Thus, based on discussions with experts, as well as future policies, directives, and actions currently under consideration by the administration, CSIS has summarized four option sets intended to improve commercial access to space. These options sets are:

- Leveraging foreign launch providers;
- Increasing domestic U.S. competition;
- Expanding the U.S. government role in space launch; and
- Enhancing launch demand.

These option sets collectively encompass the range of options under consideration within the administration and as reflected by those interviewed by CSIS during this project. They represent broad policy approaches that were discussed, advocated—and opposed—by various interviewees, and the cover, we believe, the full range of options open to decisionmakers. The option sets are not mutually exclusive. Many specific actions could be taken to implement them, and the list of possible actions included in this report is not meant to be comprehensive. Nor are all of these actions necessarily exclusive to a particular policy approach; some are common to more than one.

CSIS's intent in this report is to help define the trade space available to improve commercial access and put that trade space in a broad policy context. CSIS has, however, developed a structured framework for analysis of the options to improve commercial access to space, presented in Part 4 of the report. This framework offers policy analysts and decisionmakers a set of criteria against which the options and specific actions can be judged. CSIS conducted an evaluation of the options using these criteria, presented in Part 5. We believe that the factual, policy, and evaluative context laid out in the report can provide a comprehensive template to help inform decisionmakers in their complex task of directing policy and programs in this important area.

1. A. Thomas Young et al., *Leadership, Management, and Organization for National Security Space* (Alexandria, Va.: Institute for Defense Analyses, 2008), 19.

A. Option Set I: Leverage foreign launch providers

Multinational alliances and globalization across the entire commercial space sector, especially in the communications satellite segment, have increased tremendously, presenting both new challenges and opportunities for U.S. national security.[2] The March 12, 2010, *Space Posture Review: Interim Report* states, "Growing international and commercial interest and expertise in space presents opportunities for the United States for further collaboration and partnership in support of U.S. national security space activities, and the global community at large."[3] This option set explores two approaches to leveraging foreign launch providers—(1) the U.S. government may enter into explicit partnerships with foreign providers to assure launch for commercial and government payloads; or (2) the U.S. government may reevaluate, remove, or streamline certain export control policies and regulations.

While the analysis and evaluation of this option set focuses on improving commercial launch customers' access to space, the policies and actions regarding foreign launch providers have been in the past—and most likely will continue to be—used to leverage trade policy, technology control and innovation policy, geopolitics, and national security. U.S. government interaction with foreign launch providers has a complex history, often following several avenues at once and often at cross purposes.

A.1. Possible actions. Recognizing the importance of commercial launch capabilities internationally and nationally, the U.S. government could explore avenues to leverage the world launch market by entering into strategic partnerships.

Current U.S. government international cooperation—including DoD partnerships to conduct space operations—is a patchwork of agreements that vary according to the nations involved and make collaboration among multiple partners more difficult. This patchwork reflects the simple fact that there is no coherent, structured U.S. government strategy for commercial space access that can create synergies within international relationships. The *Space Posture Review: Interim Report* notes, "The long history of cooperation in civilian space programs and U.S. government partnerships with commercial space service providers can serve as a foundation for collaborative global action to shape the future space environment."[4]

One example of such collaboration would be a U.S. government–Arianespace, ILS, CGWIC, or ISRO[5] partnership to utilize foreign launch sites and assure launch access prioritization. The U.S. government would enter into negotiations to assure mutual access to and sharing of industrial base capacities and capabilities. Such arrangements could begin with national security assets or commercial satellites with hosted payloads. The main goal would be to view the launch enterprise as a global one, with a global industrial base and global interests. One goal, from a U.S. perspec-

2. Linda L. Haller and Melvin S. Sakazaki, "Commercial Space and United States National Security," 2001, (prepared for Commission to Assess U.S. national Security Space Management and Organization), http://www.fas.org/spp/eprint/aritcle06.html.

3. *Space Posture Review: Interim Report.*

4. Ibid.

5. India is developing a medium launch vehicle (the GSLV-D3) with the lift capacity to launch about 2,200 kg into geosynchronous transfer orbit. This is still smaller than many large satellites in geosynchronous earth orbit. Any agreement with ISRO would depend on the successful development of larger launch vehicles. For more information, see "GSLV-D3 / GSAT-4," ISRO, April 2010, http://www.isro.org/gslv-d3/pdf/GSLV-D3_GSAT-4%20Brochure.pdf.

tive, would be to ensure it maintains access to space in the face of technical launch problems or natural or man-made disasters affecting U.S. launch sites.

To more effectively leverage foreign launch providers and improve access for commercial launch customers, the United States should consider using existing legal authority, such as detailed in the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991, to issue export authorizations for commercial satellite launches, consistent with national security requirements, to all foreign launch providers.

The United States should also seek to reform its complex system of U.S. export control laws and regulations. U.S. access to foreign space capabilities faces a significant challenge because of this complex system, which fails to acknowledge the dynamics of global space commerce. Action to address this could consist of statutory and regulatory reform, including, but not limited to, possible changes to the ITAR that implement the Arms Export Control Act (22 U.S.C. 2778). In the last several years, the Departments of State, Defense, and Commerce have undertaken numerous export control reviews with a push toward actionable recommendations. Most recently, President Obama formed an interagency task force in August 2009 to review export regulations. He announced initial results of his administration's efforts at a March 2010 U.S. Export-Import Bank conference, noting that the "reform program will enhance national security by focusing on the enforcement of strict controls around the export of the most critical technologies and products, while strengthening the competitiveness of key manufacturing industries in the U.S. by streamlining the regulations that apply to their exports."[6] Several options are under consideration for reforming this system:

- In Congress, efforts[7] are under way to update the Export Administration Act, writ large, and several legislators have voiced strong support, in particular for moving satellites and related components from the State Department–administered U.S. Munitions List (USML) to the Commerce Department–administered Commercial Control List (CCL).
- These endeavors complement broader efforts in the executive branch to reform the "byzantine amalgam of authorities, roles, and missions scattered around different parts of the federal government"[8] and update antiquated Cold War restrictions found in the Arms Export Control Act and Export Administration Act, in part by creating a single export control list. In April 2010, Secretary of Defense Robert Gates outlined an export control reform plan that includes "a single export-control list, a single licensing agency, a single enforcement-coordination agency, and a single information-technology system,"[9] with possible changes enacted before the end of the year. Although implementation details remain undefined, including the extent and likelihood of needed legislation, this plan has the potential to reform to a significant degree U.S. export control policies and administration.

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6. "President Obama Details Administration Efforts to Support Two Million New Jobs by Promoting New Exports," White House, Office of the Press Secretary, March 11, 2010, http://www.whitehouse.gov/the-press-office/president-obama-details-administration-efforts-support-two-million-new-jobs-promoti.

7. *Foreign Relations Authorization Act, Fiscal Years 2010 and 2011*, HR 2410, 111th Cong., 1st sess., 2009, included language to strengthen America's satellite industry, as did *Strengthening America's Satellite Industry Act*, HR 3840, 111th Cong., 1st sess., 2009.

8. Robert M. Gates, "Export-Control Reform" (remarks to Business Executives for National Security, Washington, D.C., April 20, 2010), http://www.bens.org/mis_support/Gates%20Export%20Speech%204-20-10.pdf.

9. Ibid.

CSIS's 2008 Recommendations Still Hold

The CSIS report of 2008, "Health of the U.S. Space Industrial Base and the Impact of Export Control,"[1] recognized the lack of strategy for international partnerships, acknowledged the challenge of outdated export restrictions, and offered nine recommendations, updated as necessary, that highlight the enduring need to focus attention on key areas for successful collaboration and reform:

1. The administration and Congress should review and reconcile the strategic intent of space-related export controls. Given the importance of space capabilities to national security, a key challenge has been the chasm between the administration and Congress regarding the strategic intent of space-related export control policies and, as a corollary, the strategic role of international collaboration. Reconciling the differences between the president's policies and the legislation governing the trade in U.S. space technologies is critical to maintaining reasonable controls that help to safeguard U.S. national security.

2. Key to reconciling White House and congressional policies is identifying and controlling those space technologies that are critical to national security. The Department of Defense should identify technologies to keep on the U.S. Munitions List and subject to the State Department's International Traffic in Arms Regulations.

3. Those space-related technologies that are not deemed by DoD to be critical to national security should be moved from the U.S. Munitions List to the Department of Commerce's Commercial Control List. Examples of such non-critical capabilities include commercial communications satellites and any subsystems and components specifically designed for commercial use.

4. The appropriate executive branch departments should study whether other space systems, components, technologies, and capabilities should also be removed from the USML and review the resulting list annually. Criteria during this study and annual review should include the criticality of items and their availability outside of the United States. The notion of doing such a periodic review of items on the USML is not new. In fact, the 1999 legislation that put satellites on the USML includes language to that effect.

5. Congress should amend legislation related to satellite export licensing and include in that language a requirement to adhere to industry best practices, such as set time lines, technology thresholds, de minimis rules, and special licensing vehicles for international cooperation.

6. The secretary of defense and NASA administrator, in addition to the secretary of state, should have the authority to grant case-by-case exemptions for anomalous resolutions deemed to be in the national interest. These exemptions should occur as quickly as practicable and apply for a specific period, as both the Department of Defense and NASA require the ability to solve mission-related problems where timely international collaboration can be critical.

7. Congress should create a special program authority—resident at the Department of State with coordination by the secretary of commerce, secretary of defense, and NASA administrator—to permit timely engagement of U.S. participants in multinational space projects. This type of solution is currently in use in other communities of interest, such as the Joint Strike Fighter program. In effect, such a program authority could create trusted communities for an international collaborative space program whose members—once vetted and deemed "safe"—would be exempt from specific space-related export controls.

8. Congress should increase the notification threshold for satellite exports and establish a mechanism to allow the threshold to adjust with inflation. In some cases, Congress has not adjusted thresholds in several decades, failing to account for a variety of pricing factors including, but not limited to, inflation.

9. Relevant space-related government agencies should collaboratively undertake an annual assessment of their industrial base. This is related to the principle noted earlier in this report that all U.S. space activities are interrelated, which means analyzing them from the perspective of the entire community of government users is important. The administration's Space Interagency Policy Committee manages the development and implementation of U.S. space policy, which includes commercial use of space and the defense industrial base as it relates to space. In addition, the Space Industrial Base Council—formed in 2007—includes many of the important actors and could be a venue for launching future analyses of the U.S. space industrial base.

Note

1. "Health of the U.S. Space Industrial Base and the Impact of Export Control," CSIS, February 19, 2008, http://csis.org/event/health-us-space-industrial-base-and-impact-export-control

- A third approach would involve using a fast-tracking system such as the one developed after the launch of Operation Enduring Freedom: executive branch agencies could identify tiers of allies for which to speed up reviews while operating within existing legislation and using existing control lists. Reforming the "rule set" for how ITAR is applied could also be valuable by offering a reassessment of which technologies need to be controlled for export and dealing with issues of timing, review, transparency, and cost in the export licensing process.[10]

A.2. Potential benefits. As the *Space Posture Review: Interim Report* states succinctly: "New opportunities for partnership and collaboration with both international and commercial space actors have the potential to support future national security space activities and enhance U.S. leadership."[11]

Forming alliances. Encouraging cooperation with foreign entities could provide several benefits to the United States, including ensuring continued U.S. access to space after a technical failure or a launch facility calamity, strengthening the competitive position of the U.S. commercial satellite sector, enhancing the U.S. position in partnerships, and reinforcing collaboration among other space-faring nations.

As the Booz, Allen & Hamilton 2000 defense industry "Viewpoint" notes, strategic commercial alliances: (1) provide capabilities to expand quickly service offerings and markets in ways not possible under time and resource constraints; (2) earn a rate of return 50 percent higher than base businesses—"returns more than double as firms gain experience in alliances"; and (3) are a powerful alternative to acquiring other companies because they "avoid costly accumulation of debt and buildup of balance sheet goodwill."[12]

In those respects, international commercial alliances could help U.S. firms access foreign funding, business systems, space expertise, technology, and intellectual capital and increase U.S. industry's market share overseas, thus providing economic benefits to the United States. Moreover, U.S. experiences with foreign entities in foreign markets could help those entities obtain the requisite approvals to operate U.S. government satellite systems in other countries, resolve satellite spectrum and coordination issues, and mitigate risks associated with catastrophic domestic launch failures by providing for contingency launch capabilities from foreign nations.

Multinational alliances would also signal U.S. policymakers' intent to ensure U.S. commercial and military access to space within a cooperative, international domain, help promote international cooperation, and build support for U.S. positions within various governmental and business forums. First, partnerships could allow the United States to demonstrate greater leadership in mitigating those shared risks related to vulnerability of space assets through launch facility and data sharing, offering improved space situational awareness, establishing collective security agreements for space assets, exploring space deterrence and satellite security doctrines, and formulating and agreeing to rules of the road on the expected peaceful behavior in the space domain.[13]

Second, partnerships could also help the United States build consensus on important space-related issues in bilateral or multilateral organizations such as the United Nations, the International

10. Eligar Sadeh, "Space Policy Questions and Decisions Facing a New Administration," *Space Review*, June 9, 2008, http://www.thespacereview.com/article/1146/1.

11. *Space Posture Review: Interim Report*, 10.

12. John R. Harbison, General Thomas M. Moorman Jr. (USAF, Ret.), Michael W. Jones, and Jikun Kim, "U.S. Defense Industry under Siege: An Agenda for Change" (Booz Allen & Hamilton, 2000), 19.

13. Eligar Sadeh, "Space Policy Questions and Decisions Facing a New Administration."

Telecommunication Union, and the World Trade Organization; working with emerging space-faring nations is particularly important because of their growing presence in the marketplace and participation in international organizations.[14]

Third, alliances could serve as a bridge to future collaborative efforts between U.S. national security forces and U.S. allies. For example, civil multinational alliances such as the International Space Station and the international search and rescue satellite consortium, Cospas-Sarsat, involve multiple countries partnering to use space for common public global purposes.[15] Finally, developing government, business, and professional relationships with people in other countries provides opportunities for the United States to further the principles upon which U.S. national security relies—competition, economic stability, and democracy.

Reforming export control policies and procedures. In addition to encouraging partnerships with foreign providers, the U.S. government may choose to reevaluate, revise, or reconsider certain export control policies and procedures. U.S. policy leaders, including President Obama, President Bush,[16] and Secretary of Defense Gates, have concluded that export control reform would offer many benefits, but fundamentally it would help strengthen the space industrial base by improving the competitiveness of the U.S. space industry, providing greater opportunities to compete overseas and improving U.S. access to foreign technology. For example, the administration should consider using existing legal authority to issue export authorizations for commercial satellite launches; in China-specific cases, the law requires suspending exports of U.S.-origin satellites intended for launch from a Chinese launch vehicle but allows the administration to waive that suspension for individual launches. Such efforts would enable the U.S. government to act on behalf of industry to help foster an open, free market environment in global space commerce.[17] CSIS notes that the Defense Technology Security Administration has established national security procedures for foreign launches, which have been the foundation for enabling foreign launches of U.S.-origin satellites to date, and the United States is capable of establishing security procedures for future situations.

Reforms could also alter the export control system so that it would be "better able to respond quickly and effectively to evolving security threats, and promote our nation's continued economic and technological leadership."[18] The broader list of export control reforms described above, including a single list of controlled technologies, would end executive branch jurisdiction confusion between the USML and CCL and establish independent control criteria to screen items for control in a new tiered control list structure.[19]

Moving toward a sounder export control regime would help rationalize it with the goals of the National Space Policy. One of the 2006 National Space Policy goals was to "encourage international cooperation with foreign nations on space activities that are of mutual benefit,"[20] and the 2010

14. Ibid.

15. Ibid.

16. President Bush's technology agenda stated, "The current high tech export control system is awkwardly structured, hindering U.S. businesses, while failing to strengthen our national security."

17. National Space Forum 2008, sponsored by the Eisenhower Center for Space and Defense Studies at the United States Air Force Academy and CSIS.

18. "Recommendations for Modernizing Export Controls on Munitions List Items" (Washington, D.C.: Coalition for Security and Competitiveness, 2007), http://www.securityandcompetitiveness.org/files/muntions_list_recommendations.pdf.

19. "Fact Sheet on the President's Export Control Reform Initiative," White House, April 20, 2010.

20. Ibid. 2.

National Space Policy stated a goal to "actively promote the export of U.S. commercially developed and available space goods and services, including those developed by small- and medium-sized enterprises, for use in foreign markets, consistent with U.S. technology transfer and nonproliferation objectives."[21] Yet the current export control regime impedes the continuation of the U.S. legacy of beneficial collaboration with foreigners, according to some critics.[22] The 2006 National Space Policy also stated that departments and agencies of the U.S. government shall "refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities, unless required by national security or public safety"[23] and that "space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably."[24] The 2010 policy guidance was consistent, noting that "departments and agencies should seek to enhance the competitiveness of the U.S. space industrial base while also addressing national security needs."[25] The USML is increasingly inconsistent with this guidance since satellites and their components placed on the USML are more and more available internationally. As previously noted, U.S. export control policy has probably created the unintended consequence of encouraging the proliferation of space capabilities, has not prevented the rise of other space powers, and has had an adverse impact on the U.S. industrial and technological base. Export control reforms could help reverse this impact and reduce the growing separation between the U.S. space establishment and the emerging non-U.S. space establishment.

In sum, export control reform—whether through moving satellites and related components from the USML to the CCL, creating a single export control list, or altering the existing framework through streamlining the licensing process or using existing legal authority to waive existing suspensions—could potentially put our national space policy on a more consistent footing and enhance the competitiveness of the U.S. space industry.

A.3. Potential challenges. According to the *Space Posture Review: Interim Report,* "Leveraging partnership opportunities may lessen known risks; however they could also create a new set of complexities that must be carefully managed."[26]

U.S. companies are forming alliances with foreign companies, entering foreign markets, and investing U.S. dollars and resources overseas. At the same time, foreign companies are forming partnerships with U.S. businesses in the United States, entering the U.S. satellite market, and investing foreign dollars and resources in the United States. As a result of these trends, companies are becoming more global. One company may have multiple owners around the globe, and one product may have multiple producers. That companies of one nation are gaining greater access to the business strategies, systems, products, and employees of companies from other nations is not necessarily of concern. Particular alliances or circumstances, however, could raise national security concerns based on the nations, entities, policies, and technologies involved. In these situations, the U.S. government should balance national security and commercial space considerations, including enhancing U.S. competitiveness.

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21. "National Space Policy of the United States of America." June 28, 2010.
22. Amy Klamper, "Obama Space Policy to Emphasize International Cooperation," *Space News,* November 30, 2009, http://www.spacenews.com/policy/091130-obama-space-policy-emphasize-international-cooperation.html.
23. "U.S. National Space Policy," August 31, 2006, 7.
24. Ibid., 9.
25. "National Space Policy of the United States of America," June 28, 2010
26. *Space Posture Review: Interim Report,* April 2010, 8.

Greater globalization, instant access to and transmission of information, as well as the ability to communicate virtually anywhere, anytime, may alter people's sense of national boundaries and allegiances. This shift could also give rise to new risks and threats that may require the imposition of additional—not fewer—controls.

Export control change is incremental, as underscored by the fact that executive branch agencies and Congress have been pursuing export control reform for years, without significant success. As noted above, senior officials, including the president and the secretary of defense, are advocating meaningful reforms. That said, significant congressional concerns remain, requiring difficult discussions within both the House of Representatives and the Senate. Other than initial recommendations to streamline the licensing process for certain technologies and eliminate obstacles for companies with dual- or third-country-national employees, the administration has yet to roll out its detailed, formal recommendations. On space-specific reform, the House of Representatives has already passed—twice—language that would reform the licensing process. These pieces of legislation have yet to move through the Senate, and, given the current political environment, it is unclear whether substantive legislation will be considered, conferenced, and signed into law before the midterm elections in November.

Finally, the administration should consider exercising its existing legal authority to waive the suspension of U.S.-original satellite exports to certain countries, consistent with national security requirements. Exercising such authority can entail significant reporting; for example, the National Defense Authorization Act for Fiscal Year 1999 would require a detailed presidential report to the U.S. Congress ranging from the estimated impact on U.S. jobs to balance-of-trade effects.[27] Even with such details, some members of Congress may still find an administration's report unpersuasive based on their own expressed policy concerns.

B. Option Set II: Encourage competition among U.S. domestic launch providers

The second major option set for enhancing access to space involves encouraging more competition among U.S. launch providers. The U.S. government's role in this option set would be to encourage competition among extant and prospective entrants in the launch market as a means of expanding the launch options available to commercial satellite companies and, potentially, to government launch consumers as well. Government would serve as an enabler, possibly by providing launch infrastructure and modifying launch range policies, practices, and processes to help U.S. launch companies improve service and lower cost. However, in this option, competition in the private sector would be the primary engine that drives lower costs and prices, improved service, technological innovation, and the availability of a wider range of launch options. It would also encourage U.S. and non-U.S. commercial launch consumers to use U.S. launch providers.[28]

Today, domestic competition in the launch market is very limited. ULA is the sole provider of medium and heavy lift to the U.S. government. No other providers compete directly with ULA

27. *National Defense Authorization Act for Fiscal Year 1999,* Public Law 105-261, § 1515.

28. Michael Griffin, former NASA administrator, stated, "We believe that when we engage the engine of competition, these services will be provided in a most cost effective manner than when the government has to do it." See Michael Griffin, "NASA and the Business of Space" (remarks at the 52nd Annual American Astronautical Society, November 15, 2005), http://www.nasa.gov/pdf/138033main_griffin_aas1.pdf.

in this capacity. Orbital Sciences Corporation provides light launch vehicles and launch services, a market sector in which ULA does not compete.[29] ULA also provides medium and heavy launch vehicles and launch services to the Lockheed Martin and Boeing commercial launch companies, which compete for launches of commercial satellites. As noted, domestic competition in this arena also is anemic. Lockheed Martin and Boeing are often considered too expensive, and the lack of reliable access to launch dates is a serious liability. Further, the commercial satellite launch market is small and projected to remain so.[30]

Nevertheless, the presence of potential competitors suggests that domestic launch competition may be a realistic prospect. SpaceX is developing both light and medium-to-heavy launch vehicles, is positioned to compete for launches with ULA and Orbital, and actively seeks to compete for both government and commercial launches. SpaceX has conducted one successful light launch and one successful medium launch and has sold additional launches to clients based on the expectation of further success.[31] Sea Launch, an international consortium whose stakeholders include companies in Russia, the United States, Norway, and Ukraine, is working to emerge from bankruptcy.[32] If successful, Sea Launch will provide competition for medium and heavy launch services for commercial satellites. The fact that SpaceX seeks to enter this market and Sea Launch is seeking to reenter it indicates they believe they can compete and win in the launch business.

U.S. launch companies have demonstrated significant advantages over some of their potential competitors, including very high quality, reliability, and long experience. The extraordinary success rates of the current family of Atlas and Delta medium-to-heavy launch vehicles demonstrate these advantages.[33] Nevertheless, Lockheed Martin and Boeing have not fared well in the competition for commercial satellite launches. Lockheed Martin has launched only two commercial payloads in the past four years, and Boeing has launched none in that time frame. Two failings stand out: the inability of the government to provide reliable launch dates for commercial payloads, and the inability of commercial launch vendors to be price competitive. Finally, many observers have noted that the launch ranges are afflicted with old equipment and nonresponsive processes that inhibit timely satisfaction of commercial satellite launch requirements.

B.1. Possible actions. The U.S. government could establish policies and take a wide range of specific actions that would help facilitate commercial U.S. launch while simultaneously addressing launch facility accessibility and cost and price competitiveness.

To encourage new entrants into the launch market, the government could:

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29. Orbital is developing a medium launch vehicle, the Taurus II, but it has not yet flown.

30. FAA Commercial Space Transportation Advisory Committee, *2009 Commercial Space Transportation Forecast*, May 2009, http://www.faa.gov/about/office_org/headquarters_offices/ast/media/NGSO%20GSO%20Forecast%20June%203%202009%20lowres.pdf. 6.

31. "Launch Updates," Space Exploration Technologies Corporation, July 16, 2009, http://www.spacex.com/launch_updates.php; Peter Pae, "NASA Deal Launches Start-Up into Big Time," *Los Angeles Times*, December 25, 2008, http://articles.latimes.com/2008/dec/25/business/fi-rocket25.

32. "Home Page," Sea Launch, http://www.boeing.com/special/sea-launch/. As previously noted, the reorganization plan would give the Russian company Energia a controlling interest in Sea Launch.

33. The Delta II medium launch vehicle has not failed since 1998, and the Delta IV and Atlas V launch vehicles experienced only two partial failures in their first 32 launches. See "Boeing Launch Services: Mission Record," Boeing, 2010, http://www.boeing.com/defense-space/space/bls/missions/index.html; "Atlas V Product Card," United Launch Alliance, http://www.boeing.com/defense-space/space/bls/missions/index.html. Note that neither the Atlas V nor the Delta IV launcher is purely a U.S.-made entity; both rely on foreign-sourced materials and components.

Allow greater opportunities for new entrants in the launch market to compete for U.S. government launches. New entrants that have demonstrated reliable capability could benefit from the opportunity to compete for a larger number of launches. In providing this opportunity, the government could provide a larger and more secure business base for new entrants and encourage a wider range of options open to both government and commercial launch consumers. NASA has already taken a step in this direction by awarding contracts to SpaceX and Orbital Sciences to resupply the International Space Station.

Another factor that could contribute to this approach is NASA's cancellation of the Ares/Constellation program. In the near term, this action has been disruptive. NASA was a consumer of components and services provided by the space industrial base. In the absence of that demand, companies are uncertain of future business, and overhead charges are now allocated solely to DoD. Thus DoD launch costs could rise in the near term. In the longer term, however, NASA R&D funding and planned reliance on commercial launch vendors rather than its own launch vehicles could translate to better performance capabilities and more launches for current launch providers and new market entrants such as SpaceX. Additional launches could translate to higher production rates, lower cost, lower launch prices, and, indirectly, to better access to launch for commercial satellite launch customers.

Many of the other government actions to enhance competition would focus on enabling commercial launch vendors to compete more effectively in the commercial launch market. To help provide more reliable launch dates for commercial launch vendors and the commercial satellite consumers of launch, the government could:

Increase the launch capacity at the ranges and, as a matter of policy, reserve a modest but fixed number of slots a year for commercial satellite launches.

Mesh the launch planning cycles for government and commercial launches. Nothing compels the government to use 30–36 month launch planning horizons, and, given the uncertainty inherent in military and intelligence satellite development and launch schedules, this planning horizon may not be optimal. More coordinated planning horizons would allow commercial launch vendors a better opportunity to reserve launch slots.

Cede launch slots earlier when launch delays for government payloads are recognized. This would provide more opportunities for commercial vendors to reserve launch slots when they become available.

Overbook slots in the launch calendar with a primary mission and a backup mission, in essence recognizing that delays are a fact of life and providing more opportunities to schedule a launch.[34]

Support the development of alternative launch facilities. Seven non-federal spaceports are already in operation, and others have been proposed.[35] Although not all of these would be able to provide a full range of launch services, supporting the development of launch site alternatives could increase the availability of launch slots and, if the new sites successfully develop efficient range processes, potentially lower costs.

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34. The U.S. government and industry are reportedly working toward implementing this concept.
35. *2010 U.S. Commercial Space Transportation Development and Concepts*, 61.

To enhance range throughput, launch rate, flexibility, and responsiveness, the government could:

Provide stronger support of range modernization. The government owns, operates, and modernizes the launch ranges. Previous modernization of the launch infrastructure has been only moderately successful, and many facilities at the ranges are antiquated or obsolete.

Modify range regulations and processes. Many changes have been suggested in the past, including ramping back excessive equipment requirements, making safety requirements more realistic, moving ahead with GPS range tracking, and making regulations pertaining to commercial and government launch consistent. In his March 10, 2010, testimony before the Strategic Forces Subcommittee, Senate Armed Services Committee, Gen. C. Robert Kehler, Commander, Air Force Space Command, stated that the major goals of the Launch and Range Enterprise Transformation (LET) effort included the improvement of business practices to better support commercial partners. This echoed his 2009 testimony before the same subcommittee in which he expressed the Air Force Space Command's understanding of the importance of "fostering the growth of commercial launch capabilities."[36]

To enhance the international price competitiveness of U.S. launch providers, the government could:

Allow commercial launch vendors to charge commercial satellite customers the marginal cost of launch. This practice is not excluded as a matter of policy or regulation today. However, the current structure of the contract between the government and ULA intertwines fixed and marginal costs in a way that makes clear identification of marginal costs difficult. Renegotiation of the ULA contract would be necessary to allow only these marginal costs to be charged for commercial satellite launches. A further issue here is the sound stewardship of government funds, since the government would voluntarily pay a higher price for launch than a commercial launch customer. While the government wants to secure itself the best cost, allowing launch vendors to charge only the marginal costs to commercial launch consumers could increase the number of launches by U.S. vendors and, in turn enhance production efficiency and lower the cost for U.S. government launches.

B.2. Potential benefits. All or some combination of the steps above could help U.S. launch vendors compete more effectively for commercial satellite launches and potentially provide better launch access to commercial satellite launch customers. In the near term, they could also create incentives for ULA, the current government medium-to heavy lift provider, to attend more effectively to the commercial satellite launch market. Better scheduling practices could improve launch date reliability. Range improvements could help U.S. commercial launch vendors improve launch rates, establish more reliable launch schedules, and lower launch prices. If encouraging competition is successful and the U.S. share of launches increases, the U.S. industrial base could be become broader, more stable, and more innovative; launch prices could be contained; and launch of critical payloads would be less prone to a loss of service in the event of a catastrophic failure of a single launch vehicle.

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36. Gen. C. Robert Kehler, USAF, "Military Space Programs in Review of the Defense Authorization Request for Fiscal Year 2011 and the Future Years Defense Program" (testimony before the Armed Services Committee, Strategic Forces Subcommittee, House of Representatives, March 10, 2010); and Gen. C. Robert Kehler, USAF, "Military Space Programs in Review of the Defense Authorization Request for Fiscal year 2010 and the Future Years Defense Program" (testimony before the Armed Services Committee, Strategic Forces Subcommittee, House of Representatives, May 20, 2009).

B.3. Potential challenges. The strategy of enhancing competition faces two fundamental challenges: (1) the launch market does not always act like a true market and (2) demand for launch services is limited. Both challenges could reduce the benefit of encouraging competition as a means of expanding launch availability to commercial launch consumers.

As noted previously, launch price in the international market is not necessarily closely related to launch costs and some have argued that space launch is so dominated by government intervention that it has never been and will never be a market driven by supply and demand. Thus, critics of this option could maintain that no matter how efficient U.S. launch vendors become, they will never be able to offer lower prices than government-owned or highly subsidized competitors.

Other critics might contend that encouraging competition is not an economically viable option. It could simply encourage a large number of launch providers to compete for a limited number of launches with little prospect that demand for launch will increase in the foreseeable future—a path that may not be economically sustainable. U.S. launch providers have only two potential markets to pursue: U.S. government launches and commercial satellite launches. NASA funds 10–12 launches per year; DoD funds about the same, only half of which are medium or heavy launches. Commercial satellite launch consumers require about 15 geosynchronous launches and 10 non-geosynchronous launches a year.[37] Launch forecasts are never made with certainty, but current forecasts do not indicate that demand will increase. Thus, prospects for market growth appear modest. Many observers have noted that support for two EELV providers in the 1990s was predicated on the twin notions of a substantial commercial launch market and competition. When the commercial launch market did not meet expectations, neither vendor was able to sustain itself, finally resulting in the merger of Boeing and Lockheed Martin to create ULA.

A secondary implication of this situation is that a broader industrial base may not be, in the long term, a healthier industrial base. If market demand is not sufficient to sustain additional launch providers, an industrial base that expands in the near term may simply consolidate in the longer term as those additional providers depart the launch market.

C. Option Set III: Increase the U.S. government's role in the domestic commercial launch market

To a significant degree, the strategy of increasing government support for and control over the domestic launch market is the inverse of the strategy of enhancing competition. Instead of relying on commercial competition among launch vendors to improve service and drive lower prices, the U.S. government itself would seek to set conditions that would assure the availability of launch services for both itself and commercial launch consumers. In this scenario, government, rather than competition, would become the "engine" to reduce costs and prices and drive technological progress.

This strategy could be executed in various forms. At one extreme, the government could take an arsenal approach, in which it would own and operate the facilities needed to build launch vehicles and infrastructure, integrate payloads and launch vehicles, operate the ranges, and conduct the launches. This study, however, will focus on a less intrusive approach. The fundamentals of this

37. Office of Commercial Space Transportation, Federal Aviation Administration, *2010 Commercial Space Transportation Forecasts.*

variant would include a conscious policy of limiting competition and acquiring launch services from one key vendor, optimizing government practices to reduce cost and enhance efficiency, and prioritizing the ability to launch commercial payloads from U.S. ranges.

This option would be intended to make today's practice—in which the government already relies very heavily on one key launch provider—more efficient and to match it with current policies. Some contend that today's policies are too inconsistent to be effective, supporting at the same time a single principal launch provider, the development of a domestic commercial launch industry, competition both within the United States and with foreign launch providers, and potentially cooperation with foreign launch providers. All of these approaches seek to provide higher quality launch services to both U.S. government and commercial launch consumers. However, a strategy focused on government support and control to improve commercial access to launch would be based on the contention that the launch market is too limited to support multiple competitors within the United States.

C.1. Possible actions. To rationalize the launch industry, the government could:

"Pick a winner." This option rests on the contention that domestic competition in the launch industry is not viable. Picking a winner in essence requires the government to select and work with a single launch provider. Such a course would avoid potentially destructive price competition that led to significant financial losses for the Boeing and Lockheed Martin space launch companies during the past decade and may have driven Sea Launch into bankruptcy. This option does not necessarily rule out all competition: if the government concludes that SpaceX is a viable space launch alternative, a one-time competition might be possible. If the government nationalized space launch production facilities, future management competitions, similar to those now conducted by the Department of Energy for the management of the national laboratories, might also be possible.

To enhance technological progress in space launch, the government could:

Increase government R&D funding. Such a course would be consistent with the government's role in the past. Because of the cost of such systems and the lack of immediate economic payoff, the U.S. government historically has been the funding source for developing more advanced space launch systems. Indeed, SpaceX is the only privately financed space launch vehicle ever developed.[38] In the 1990s, the United States made a conscious decision to develop a new, more efficient family of launch vehicles based on legacy technologies; these became the Atlas V and Delta IV vehicles used today. At various times since, DoD provided significant R&D funds (the Space Launch Initiative and the Operational Responsive Spacelift Initiative in the 2000s) to try to advance the state of the art in space launch. DoD still spends a significant amount on R&D for space systems, but most now focuses on the development of advanced satellite systems, and funding for space launch technology in the FY 2011 budget is not robust. NASA cancelled its work on the Ares space launch vehicle this year but has requested substantial funding for development of advanced launch technologies. Increased government R&D funding for launch systems would be based on an assessment that the SpaceX development model is not viable in the future and a recognition that advanced space launch technologies will be needed to assure continued U.S. space leadership. Such an assessment potentially could push DoD space launch R&D to higher levels.

38. Virgin Galactic is currently developing a sub-orbital vehicle to be used for space tourism but has not yet tackled an orbital vehicle. The cost of EELV development in the 1990s was shared by the government, Lockheed, and Boeing.

Put in place incentives for the U.S. launch provider to innovate. This might take the form of contract incentives for the launch provider that reward the development of lower cost, more efficient, and more reliable launch technologies that offer better service for government—and thus commercial—launch consumers.

To reduce cost and price and help to assure a stable supply of U.S. launch vehicles for commercial satellite operators, the government could:

Acquire launch services in stable, lot buys. Today, DoD buys launches inefficiently, on an individual basis. That practice does not allow ULA to anticipate DoD demand and requires ULA to acquire support from its subcontractor base as though each launch is the only launch. Baseline acquisition of multiple launches would help stabilize the industrial base, particularly at the second- and third-tier levels, and allow more efficient acquisition of launch vehicles. Both government and industry now recognize the merit of this consideration and are working to develop a new acquisition strategy, but whether this new strategy will finally allow for block buys is not yet clear.

Acquire launch vehicles in advance of identified DoD launch needs. Some observers have suggested that simply acquiring launch vehicles in block buys might reduce costs to a point that the commercial satellite companies would find U.S. launch vehicles much more price competitive. Buying in advance of DoD needs could further reduce the cost of launch vehicles. Unused capacity could then be sold to the commercial satellite market at lower cost, and lower launch prices would benefit the government.

To enhance range throughput, launch rate, flexibility, and responsiveness, the government could:

Modernize the launch ranges and modify range regulations and processes. These steps could be very similar to those described in Option II. The intent would be to improve range throughput, enhance the ability to support commercial launches, and lower costs associated with the launch range to better attract commercial satellite launch consumers.

To enhance price competitiveness, the government could:

Provide direct subsidies to the U.S. launch provider. A consistent theme in the interviews was that ULA launch services were not price competitive with those provided by foreign launch services. This lack of price competitiveness might result from any number of causes—inefficiencies, over-facilitization, inferior technology—but it might also occur because foreign launch competitors are simply more heavily and directly subsidized.[39] Providing a more substantial subsidy would lower the price of a U.S. launch for the commercial market.

Allow the launch vendor to charge commercial customers the marginal cost of launch. This again would be intended to attract commercial launch opportunities, resulting in the potential for larger production runs for space launch vehicles, which should reduce per vehicle manufacturing costs, build a more robust industrial base, and allow for the amortization of range costs over a larger number of launches. The government could also reasonably expect to benefit from each of these results.

39. All launch providers are subsidized in one form or another, at a minimum through provision of infrastructure. How much the various launch providers are subsidized and how subsidies affect competitiveness is not easy to determine. See Jeff Foust, "How Competitive is Commercial Launch?" *Space Review*, October 19, 2009, http://www.thespacereview.com/article/1493/1.

C.2. Potential benefits. Other benefits might accrue from this approach in addition to lower launch prices. Stability—and thus a healthier industrial base—could be assured for the launch provider selected and supported by the government. The government's commitment to sustaining a viable launch industry would very likely offer assured and secure access to space from a domestic launch service. Such assured access would presumably extend to critical payloads on commercial satellites and reduce the commercial launch consumers' reliance on foreign launch providers.

C.3. Potential challenges. The strategy of enhanced government control faces two key challenges in implementation: creating incentives that encourage innovation and containing costs and prices.

The commonly accepted U.S. paradigm is that private enterprise and competition are the most effective means of encouraging innovation. Option III, focused on picking a winner, would almost certainly suppress competition. While contract incentives for a single launch provider may suffice to encourage such innovation, a single provider in a secure relationship with its buyer may find it more beneficial to continue performing successfully with proven technologies than to speculate on new technologies for marginal economic return or to penetrate small and not very lucrative markets. The government's strong focus on mission assurance may also discourage innovation; relying on proven but perhaps less efficient technologies and processes may be safer than employing new technologies that promise improved performance. Government efforts to spur the development of new launch technology have certainly given rise to more powerful and more reliable rockets. At the same time, these efforts have not been notably successful in producing technical or operational transformation. This could be because the technical hurdles are high and new enabling technologies are not sufficiently mature, but the lack of success does raise a question about the government's ability to spur innovation.

Concerning cost, the key issue is whether cost control efforts are likely to be successful when the government relies on a single launch provider. The government clearly has a need for assured access to space. Relying on a single provider, however, could put the government in a weak negotiating position in its efforts to contain launch costs, and the launch provider could conclude that a higher profit margin on fewer, exclusively government launches is a more plausible business model than pursuing the uncertain and relatively small commercial satellite launch market.

The government would also have to consider the benefits of sustaining two families of launch vehicles, as it does today with ULA, against the benefits of having only one launch provider. The risk of catastrophic failure might be deemed insufficient to justify the additional cost, or it might be offset through some international cooperative agreement.

D. Option Set IV: Enhance demand for launch

One of the key factors that has shaped the launch industry is the relatively sparse demand for launch. In the late 1990s, the expectation of significant commercial demand for launch led the government to support two launch vendors, but when that demand collapsed, neither U.S. vendor was economically viable on its own. Many observers note that limited demand means a low launch rate, inefficient operations, and a fragile industrial base. While the commercial satellite industry has inadequate access to launch capability today, the lack of demand may inhibit the development of a launch market that can more adequately provide that access.

One approach, therefore, to improve cost-effective access to the launch market for commercial satellites is to enhance demand, which in turn could enhance the development of new launch

sources and a healthier launch market. Rather than focus directly on supply, the government in this approach would focus on policies and practices intended to diversify the type and increase the number of payloads launched. Government officials, including the acting director of the office of space commercialization at the Department of Commerce, have publicly supported enhancing demand as a way to promote and aid the commercial sector.[40] The Air Force's FY 2011 budget request also continues the commercially hosted on-orbit wide-field-of-view technology demonstration effort. This commercial partnership is an important example of how the U.S. government could continue to increase demand for launch.[41]

Enhancing demand could involve efforts to encourage new applications of space technologies, reduce the complexity of satellites, lower satellite costs, shorten development times, and explore architectures that focus on large constellations of individually less capable satellites (as opposed to few constellations of very capable satellites). All of these approaches could result in a larger number of launches that, in turn, could stimulate the launch community to meet the increased demand, broaden the industrial base, reduce launch vulnerabilities, and ultimately improve launch access for commercial customers.

D.1. Possible actions. To encourage new commercial applications of space technologies, the U.S. government could:

Pursue integrated policies to reduce the barriers to market entry. The development of new economic applications for space technologies could be one key to enhancing demand for launch, but space operations are expensive, and early return on investment is often unlikely. Prospects for any commercial activity in space would rest on economic analysis by industry interested in making a profit. Some of these prospects devolve to a chicken-and-egg issue—low-cost access to space and more advanced space technologies enable such developments, but without commitments from those interested in pursuing commercial opportunities that might drive launch advances, they are less likely to be pursued. The government could pursue policies to encourage expansion of space commerce to help move past this conundrum. These might entail means of providing a more positive business environment; for example, offering tax incentives or limiting liability. Enhanced government R&D for potential commercial space applications might also be part of this approach.

Renew its interest in enhanced R&D funding for low-cost access to space. The government has pursued such initiatives in the past, without notable endurance or success. If the cost of access to space were to be significantly reduced, the business case for space ventures might also improve.

To reduce the size, complexity, and cost of satellites, the government could:

Disaggregate payloads. One of the key cost and schedule drivers for space programs today is the integration of very complex technologies on multi-mission satellites. The Mobile User Objective System (MUOS) satellite program, for example, is suffering delays because of difficulties integrating two payloads.[42] Separating payloads into smaller, less complicated satellites could avoid at least some integration challenges, lower schedule risk, and reduce satellite development costs while expanding launch opportunities.

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40. Cavossa, Edwards, Gallo, Osterthaler, and Wheeler, "New Approaches to Commercial Satcom Procurement: Fulfilling the Needs of the USG and DOD."

41. Gary E. Payton, "Military Space Programs in Review of the Defense Authorization Request for Fiscal Year 2011 and the Future Years Defense Program" (testimony before the Senate Armed Services Committee, Strategic Forces Subcommittee, March 10, 2010).

42. "Inside the Navy," March 29, 2010, 1.

Pursue Operationally Responsive Space (ORS) more aggressively. ORS is an effort within the DoD to develop enabling technologies and a concept of operations that more effectively meet the military needs of joint force commanders. It focuses in part on agility with current space assets but also concentrates on developing the ability to meet such needs with responsive development and launch of smaller, less complex satellites based on proven technologies. This would shorten development times and standardize key space hardware, such as satellite buses that enable lower-cost production. Low-cost (or at least lower-cost) launch would be key to ORS success.[43] The effort is very modestly funded today; more aggressive funding could lead to more rapid application of some ORS concepts and technologies.

To enhance demand for existing commercial satellite services, the government could:

Explore new contractual arrangements for commercial satellite services. In the past, the government purchased commercial satellite communications largely on the spot market. This has been an inefficient and expensive way of acquiring such capabilities, since satellite operators charge a premium for unplanned business for which they cannot presume future business. In the future, the Defense Information Services Agency of the DoD intends to procure such services using longer-term contracting. The Future COMSATCOM Services Acquisition program uses a number of contracting vehicles to acquire both fixed site and mobile communications from commercial satellite communications companies.[44] The new approach would theoretically allow the government to acquire more communications for the same amount of money. Commercial satellite communications sell principally to commercial customers, but the government share of business with these companies is substantial (the maximum in these companies is about 20 percent today), and DoD has a voracious and growing appetite for communications. Depending on the volume of business, this new approach could translate into additional satellites to meet new demand and, thus, to greater demand for launch services.

D.2. Potential benefits. Potential benefits from a demand-focused approach include lower launch costs and prices stemming from a higher launch rate, and the potential development of new launch vehicles to meet higher demand. This could result in a more robust, less brittle industrial base and a launch sector less prone to catastrophic consequences in the event of a launch failure. Should concepts such as disaggregation and ORS succeed, much larger numbers of smaller launch vehicles or a modest increase in larger launch vehicles launching multiple satellites could be used to meet enhanced demand. In either case, commercial access to launch could be enhanced.

D.3. Potential challenges. A demand-focused approach would entail overcoming significant challenges. Enhancing demand is clearly a long-term approach and would likely have only limited impact in meeting near-term requirements for improved launch access. Focusing on enhanced demand could involve a substantial restructuring of the space industry, a process that could be long and generate significant institutional resistance from both government and commercial centers with interests in the current structure and ways of doing business.

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43. See, for example, "Plan for Operationally Responsive Space: A Report to Congressional Defense Committees," National Security Space Office, Department of Defense, April 17, 2007, http://www.acq.osd.mil/nsso/ors/Plan%20for%20Operationally%20Responsive%20Space%20-%20A%20Report%20to%20Congressional%20Defense%20Committees%20-%20April%2017%202007.pdf.

44. Michael A. Taverna, "Government Satcom Procurement Shifting," *Aviation Week and Space Technology*, April 2, 2010, http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=space&id=news/asd/2010/04/02/03.xml&headline=Government%20Satcom%20Procurement%20Shifting; "Commercial SATCOM Update," Defense Information Systems Agency, April 2009.

At least two significant technical hurdles would have to be overcome. First, any approach that requires far more launches than the United States conducts today depends critically on lowering the cost of launch. How low technology and streamlined operations can drive those costs[45] and how dependent the effort is on the development of small launch vehicles remain open questions. The economics that drive launch providers may still point toward large, multi-payload launch systems to launch smaller satellites instead of a greater number small space launch vehicles. Second, for some time smaller satellites are likely to be inherently less capable than larger satellites. The ability to develop and package operationally usable and (especially for the commercial world) economically viable payloads into smaller satellites will be critical to this approach. The market has obviously not spoken yet, and the economics of various space applications—for example, communications—may still point to large satellites. One leading indicator of this is that, although the number of launches remains modest and stable, launch weight and volume have consistently increased over the years, both in the aggregate and per satellite.[46] Furthermore, small satellites are inherently incapable of some applications (large-aperture telescopes, for example), so the need to build and sustain large launch vehicles will likely continue.

45. Current U.S. medium to heavy launch vehicles are still priced at more than $100 million; current light launch vehicles are priced at about $20–25 million. SpaceX hopes to offer launches for less than half of those prices. See "Falcon 9: Pricing and Performance," Space Exploration Technologies Corporation, http://www.spacex.com/falcon9.php#pricing_and_performance.

46. FAA Commercial Space Transportation Advisory Committee, *2009 Commercial Space Transportation Forecast*, 27.

4 EVALUATION CRITERIA

Reliability

Reliability (a prerequisite for mission assurance) of the commercial space launch vehicle is a key factor in the evaluation. CSIS will assess the near- and longer-term implications of each option to determine the extent to which it would maximize:

- The efficient use of the U.S. launch infrastructure and improved launch processes that reduce setup and dwell time and increase potential launch volume both overall and at individual launch facilities.
- Safe and effective U.S. range throughput (operational tempo), potentially resulting in increased skill levels within the launch team, reducing technical risks.
- Responsiveness to changes in demand. The ability to adapt consistently and effectively to unexpected demand increases or decreases would have positive economic and safety implications for U.S. launch facilities.

Reliability considerations also include the extent to which the option would minimize:

- The probability of technical failures that could cause catastrophic destruction of the launch vehicle. The consequences of such a failure are broader than just loss of the individual hosted satellite(s) and the resulting lost-payload financial and opportunity costs. Failure also could delay planned future launches until root causes are identified and corrective action determined and implemented.
- The potential impact of natural or man-made disasters. Geographical concentration of space launch facilities in one or a few physical locations can make assured U.S. access to space more vulnerable to disruptive events such as hurricanes, earthquakes, fire, or explosion.
- Schedule disruptions arising from the higher priority placed on national security and civil (NASA) payload launches. Historically, because of chronic delays, national security payload launches have been especially difficult to schedule accurately. Schedule unpredictability has made it difficult to ensure that lower-priority commercial payloads can be launched from common U.S. launch facilities, as planned, in accordance with customer requirements.
- The risk that a foreign government could delay or deny space launches carrying payloads important for U.S. government applications. This criterion addresses the ability of a foreign government to delay or deny, the likelihood that the delay or denial would occur, and the significance of the impact, if it did occur.[1]

1. For example, the DoD is dependent on foreign sources for many products used in important military applications, and foreign dependency certainly meets the "ability" test. To date, however, published DoD

Security

This criterion addresses the extent to which the option would facilitate:

- Appropriate launch vehicle or payload technology dissemination.
- Limiting potential compromise of satellite performance.
- Improvement, protection, and preservation of the industrial base as necessary to:
  - Sustain essential industrial capabilities (personnel, technologies, or facilities) necessary to develop, design, produce, and support satellites and launch vehicles. National security and national sovereignty may require that the United States create and sustain certain defined essential industrial and technological capabilities necessary to develop, design, produce, and support satellites and launch vehicles needed for key U.S. government applications. In this context, essential industrial and technological capabilities could be determined to be those key to achieving current and projected performance, cost, and schedule contractual requirements; those on which military superiority depends; those based on important emerging technologies; those available from few reliable sources; and those that would be difficult, time-consuming, and costly to reconstitute, if lost.
  - Mitigate risks associated with incongruent strategic interests between the provider and the U.S. government. Such misalignment could lead to the evolution of space- or launch-related technologies and products in a direction inconsistent with U.S. government needs.

Affordability

Launch prices can be market driven, not cost driven. This criterion, therefore, reflects the near- and long-term option implications on launch vehicle cost and price, including the likelihood that the option would lead to:

- Technological innovation that would improve reliability or performance, facilitate multiple trips to space and return, and reduce costs.
- New, or improved existing, launch facilities; and more efficient launch processes.
- Price decreases in both the near and long terms. CSIS will examine the extent to which option beneficiaries would:
  - Decrease prices consistent with realized cost reductions.
  - Have sufficient market clout to be able to manipulate prices to drive out competition. Assuming the ability to manipulate prices, CSIS also would examine the likelihood that such manipulation would occur and the significance of the manipulation, if it did occur.

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studies (for example, "Study on Impact of Foreign Sourcing of Systems," January 2004) have indicated that these foreign suppliers continued to meet DoD contract requirements despite their use in "unpopular" wars. Therefore, foreign dependency does not necessarily meet the "likelihood" test.

Feasibility

For this criterion, CSIS evaluates the extent to which the option is feasible and actionable. Considerations include the extent to which the option:

- Is consistent with U.S. government laws, policies, objectives, and culture.
- Minimizes complexity of implementation.
- Minimizes resource requirements (financial, personnel, political).
- Leverages market dynamics.

Timeliness

CSIS assesses the time line within which the option could be implemented as well as the time line within which positive results could be demonstrated.

5 EVALUATION OF OPTION SETS

CSIS convened a group of subject matter experts to evaluate the option sets summarized in Part 3, using the evaluation criteria outlined above. The group evaluated actions (or groups of actions) within each option set to determine the extent to which it supported or did not support each of the criteria. The matrices and key points that follow summarize results.

As noted earlier, the possible actions within each option set are not mutually exclusive. Although the CSIS experts did not do so, different actions from each option set could be combined and evaluated within a new composite option.

The Reliability, Security, and Affordability evaluation criteria discussed below allow CSIS to assess the likely impact of potential options, if implemented. CSIS also has developed two additional evaluation criteria designed to consider potential factors associated with implementing options: potential implementation difficulties (Feasibility) and the length of time it would take for options to be implemented and results obtained (Timeliness). Note that the criteria themselves, with one exception, inherently embody a sense of value. For example, minimizing the risk of technical failure is generally "good." The one exception is timeliness: short-, mid-, and long-term impact can all be positive, particularly in some combination.[1] Note also that the evaluation criteria are not weighted, and CSIS has not attempted to determine which are more important than others.

This evaluation by CSIS experts is intended to provide to policymakers a better understanding of the options before them regarding commercial access to space. CSIS believes that the data and perspectives in this report, the options, the criteria, and the evaluation process are valuable tools for those policymakers; other experts with different perspectives evaluating the options could come to different conclusions concerning the contributions the options make to the criteria.

The evaluation results are coded as follows:

Evaluation Key:

– – Significant negative	– Minor negative
0 Neutral	
++ Significant positive	+ Minor positive

Note
R&D = research and development
USG = U.S. government

1. For timeliness, a "++" evaluation indicates the action could be accomplished and results obtained very quickly. A "--" evaluation indicates the action would take an extended period of time to implement and obtain results. For this criteria, "0" (neutral) is not an option.

Option Set 1: Leverage foreign launch providers

Table of evaluation criteria

A. Reliability	Possible actions: USG enter into strategic partnerships	USG move satellites and components from USML to CCL	USG create single export control list	USG streamline existing licensing process and/or employ legal authority to waive suspensions
1. Maximize efficient U.S. infrastructure/processes	0	0	0	0
2. Maximize safe/effective U.S. throughput	0	0	0	0
3 Maximize U.S. responsiveness to change	+	0	0	0
4. Minimize U.S. technical failure risk	0	0	0	0
5. Minimize U.S. disaster impact	++	0	0	0
6. Minimize U.S. priority schedule disruptions	+	0	0	0
7. Minimize U.S. risk of foreign nation delay/deny	+	0	0	0

Notes on Reliability:

- None of the possible actions under Option 1 would have a discernible effect on maximizing efficient U.S. infrastructure/processes, maximizing safe and effective U.S. throughput, and minimizing U.S. technical failure risk. Neither would the three actions associated with export control and licensing because these possible actions are focused on satellites and satellite components rather than launch facilities.
- If the U.S. government entered into strategic partnerships with foreign launch providers to provide guaranteed stand-by launch capability, the action would have a significant positive effect on minimizing the impact of a disaster scenario at U.S. launch facilities and a minor positive impact on maximizing U.S. responsiveness to change, minimizing U.S. priority schedule disruptions and minimizing U.S. risk of foreign national delay or denial.

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B. Security	USG enter into strategic partnerships	USG move satellites and components from USML to CCL	USG create single export control list	USG streamline existing licensing process and/or employ legal authority to waive suspensions
1. Appropriate technology dissemination	–	+	++	+
2. Limit potential performance compromise	–	0	0	0
3. Strengthen industrial base	0	+	+	+

Notes on Security:

- Inherent within this option is increased participation by non-U.S. providers and a potential increase in the risk of inappropriate technology transfer and compromise of satellite performance. Such risks are difficult to quantify and are sometimes controversial. CSIS received many animated comments, some asserting that the risks are well understood and well controlled, and others maintaining that security risks are still substantial. Most believe security risks posed by allies are minimal. If the government entered into strategic partnerships, this would have a minor negative impact for facilitating appropriate technology dissemination and limiting potential performance compromise because a greater opportunity for security issues to arise is inherent with non-U.S. participants.
- Moving satellites from the USML to the CCL or streamlining existing licenses practices and using existing legal authority to waive suspensions of exports would have a minor positive impact on facilitating appropriate technology dissemination and on strengthening the industrial base as it would provide U.S. industry more opportunity to compete globally and export its technology.
- A single export control list would have a significantly positive effect on the appropriate dissemination of technology—the main objective of the action—and strengthen the U.S. industrial base. In addition, a single export control list would allow a single licensing agency—in coordination with relevant interagency partners—to control certain technologies strictly when they are first introduced but would also ease those controls later, when the technology is more widely available. This cascading function would also serve to enhance appropriate technology dissemination.

C. Affordability	USG enter into strategic partnerships	USG move satellites and components from USML to CCL	USG create single export control list	USG streamline existing licensing process and/or employ legal authority to waive suspensions
1. Technological innovation	0	0	0	0
2. New/improved launch facilities/processes	0	0	0	0

(continued next page)

3. Near/long term price decreases	–	0	0	0

Note on Affordability:

- Generally, none of the four possible actions would have an impact on affordability. The lone exception relates to the government entering into strategic partnerships. This would have a minor negative impact owing to questions associated with cost sharing, specifically which parties would bear what portions of the cost burdens.

D. Feasibility	**USG enter into strategic partnerships**	**USG move satellites and components from USML to CCL**	**USG create single export control list**	**USG streamline existing licensing process and/or employ legal authority to waive suspensions**
1. Consistency with existing laws/policies/ objectives/culture	–	–	–	+
2. Minimize complexity of implementation	–	+	+	+
3. Minimize resource requirements	–	–	– –	+
4. Leverages market dynamics	0	+	+	+

Notes on Feasibility:

- Only government streamlining of the existing licensing process merits a positive rating within the category of consistency with existing laws, policies, objectives, and culture. The other three actions received minor negative ratings as each would entail a change to current law, policy, or culture.
- A single export control list represents a significant negative impact for resource requirements because overcoming legislative and executive branch concerns would be extremely difficult and would require the investment of significant political capital.
- Moving satellites and components from the USML to the CCL, creating a single export control list, and streamlining existing licensing processes and using existing legal authority to waive suspensions of exports merit minor positive evaluations for leveraging market dynamics, as this would open global markets to innovative and competitive U.S. manufacturers and operators.

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E. Timeliness (time to implement/get results)	USG enter into strategic partnerships	USG move satellites and components from USML to CCL	USG create single export control list	USG streamline existing licensing process and/or employ legal authority to waive suspensions
	–	+	–	+

Note on Timeliness:

- Both the strategic partnership and the single export control list options would likely take time to implement, particularly since the single export control list option would require time to gain congressional approval. Moving satellites and components from the USML to the CCL and streamlining existing processes would not require significant time to implement after a decision was made.

Option Set 2: Encourage competition among U.S. launch providers

Table of evaluation criteria

	Possible actions			
A. Reliability	Encourage new entrants for USG payloads	USG enable more effective commercial launch competition	USG enhance range launch rate, flexibility, responsiveness	USG allow commercial vendors to charge marginal cost of launch
1. Maximize efficient U.S. infrastructure/processes	++	++	++	0
2. Maximize safe/effective U.S. throughput	+	+	+	0
3. Maximize U.S. responsiveness to change	+	+	+	0
4. Minimize U.S. technical failure risk	–/+	+	+	0
5. Minimize U.S. disaster impact	0	+	+	0
6. Minimize U.S. priority schedule disruptions	++	++	++	0
7. Minimize U.S. risk of foreign nation delay/deny	++	++	++	+

(continued next page)

Notes on Reliability:

- These possible actions, except for allowing vendors to pay only the marginal cost of launch, would significantly increase opportunities for launch consumers to access U.S. infrastructure and processes, thereby increasing efficient use of those facilities. They would also encourage safe and effective throughput while simultaneously facilitating responsiveness to change by providing more launch options.
- In the initial phases of implementation, encouraging more launch providers would result in a higher potential for technical failure. With time and experience, however, accessing more and increasingly proven providers will lower this risk.
- Encouraging new U.S. entrants for U.S. government payloads, enabling more launch competition, and enhancing ranges would lead to more U.S. launch providers and U.S. launch facilities. This should have a significantly positive impact on minimizing both potential priority schedule disruption and the risk of foreign nation denial or delay.
- Range enhancement likely would have a minor positive effect on maximizing U.S. responsiveness to change. When better facilities and practices are put into place, the range would be able to operate more efficiently and effectively, dampening the effects of changes in demand.
- Allowing commercial providers to pay only marginal launch costs would have little impact on reliability. If commercial providers pay only marginal costs, incentives to drive innovation might be reduced and efficiency might not improve.

B. Security	**Encourage new entrants for USG payloads**	**USG enable more effective commercial launch competition**	**USG enhance range launch rate, flexibility, responsiveness**	**USG allow commercial vendors to charge marginal cost of launch**
1. Appropriate technology dissemination	++	++	++	++
2. Limit potential performance compromise	++	++	++	++
3. Strengthen industrial base	++	++	+	++

Notes on Security:

- All actions would facilitate the development and use of domestic launch capabilities, resulting in significantly positive security evaluations.
- By encouraging the use of U.S. launch facilities, enhancing ranges would have a positive impact on strengthening the industrial base, but less than that of the other actions.

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C. Affordability	Encourage new entrants for USG payloads	USG enable more effective commercial launch competition	USG enhance range launch rate, flexibility, responsiveness	USG allow commercial vendors to charge marginal cost of launch
1. Technological innovation	++	0	++	0
2. New/improved launch facilities/processes	++	++	++	–
3. Near/long term price decreases	++	++	+	++

Notes on Affordability:

- Generally, these possible actions would have a significant positive impact on affordability, with the exception of enabling more effective competition and permitting the marginal cost of launch, which likely would not affect technological innovation.
- If U.S. commercial satellite launch customers were to pay only the marginal costs of launch, there might be little incentive for these commercial launch vendors to seek launch facility improvements.

D. Feasibility	Encourage new entrants for USG payloads	USG enable more effective commercial launch competition	USG enhance range launch rate, flexibility, responsiveness	USG allow commercial vendors to charge marginal cost of launch
1. Consistency with existing laws/policies/objectives/culture	0	–	+	–
2. Minimize complexity of implementation	0	++	–	– –
3. Minimize resource requirements	0	++	– –	–
4. Leverage market dynamics	–	+	0	++

Notes on Feasibility:

- For many of these options, implementation will require cultural changes, not a change in the policy itself. However, both encouraging new entrants for U.S. government payloads and enabling commercial launch competition will also require changes in policy and law.
- Allowing commercial launch vendors to charge the marginal cost of launch would be complex because ascertaining true marginal launch costs will be very difficult and potentially controversial. In addition, enhancing ranges and practices likely would be very costly.
- Enabling launch competition and allowing commercial vendors to charge marginal launch costs effectively leverages market dynamics by increasing access to launch facilities, and promoting competition.

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E. Timeliness (time to implement/get results)	Encourage new entrants for USG payloads	USG enable more effective commercial launch competition	USG enhance range launch rate, flexibility, responsiveness	USG allow commercial vendors to charge marginal cost of launch
	–	+	–	+

Notes on Timeliness:

- Enabling more effective commercial launch competition and allowing commercial vendors to charge marginal costs could be accomplished rapidly once decided. The complexity and—potential controversy associated with ascertaining and assigning true marginal launch costs to commercial vendors—could result in some initial delay.
- Encouraging new entrants and enhancing range launch rate would require a significant cultural shift, despite the lack of statutory prohibition. Cultural changes are often difficult and take considerable time.

Option Set 3: Increase the U.S. government's role in domestic commercial launch market

Table of evaluation criteria

	Possible actions					
A. Reliability	USG select single launch provider	USG increase R&D, innovation incentives	USG buy launches in stable, lot buys	USG modernize ranges, regulations and processes	USG provide direct subsidies to U.S. launch providers	USG allow commercial vendors to pay only marginal cost of launch
1. Maximize efficient U.S. infrastructure/processes	–	0	0	++	0	0
2. Maximize safe/effective U.S. throughput	–	0	+	+	0	0
3. Maximize U.S. responsiveness to change	– –	0	+	+	0	0
4. Minimize U.S. technical failure risk	– –	+	+	+	0	0
5. Minimize U.S. disaster impact	– –	0	0	+	0	0

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6. Minimize U.S. priority schedule disruptions	0	0	+	++	0	0
7. Minimize U.S. foreign nation delay/deny risk	++	+	+	++	++	+

Notes on Reliability:

- Down selecting to one domestic launch provider would have either a minor or significant negative impact on the majority of the reliability evaluation criteria, primarily owing to risks associated with single point failures. Utilizing a single launch provider would have a significant positive impact on minimizing potential risks associated with foreign nation delay and denial, as the United States would not be using foreign providers.
- Increasing R&D and incentives for innovation would have a minor positive impact on minimizing U.S. technical failure risk as there could be more attention paid to preventing and mitigating such failures.
- The U.S. government buying launches in stable, lot buys would have little effect on maximizing efficient launch facility processes and infrastructure. It would maximize throughput and responsiveness to change, however, because it would promote stability within production lines, promoting increased knowledge and consistency.

B. Security	**USG select single launch provider**	**USG increase R&D, innovation incentives**	**USG buy launches in stable, lot buys**	**USG modernize ranges, regulations and processes**	**USG provide direct subsidies to U.S. launch providers**	**USG allow commercial vendors to pay only marginal cost of launch**
1. Appropriate technology dissemination	++	0	+	++	++	++
2. Limit potential performance compromise	++	0	+	++	++	++
3. Strengthen industrial base	++	+	++	+	++	++

Note on Security:

- Generally, all actions in this option should have a positive impact on security because they leverage U.S. capabilities.

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C. Affordability	USG select single launch provider	USG increase R&D, innovation incentives	USG buy launches in stable, lot buys	USG modernize ranges, regulations and processes	USG provide direct subsidies to U.S. launch providers	USG allow commercial vendors to pay only marginal cost of launch
1. Technological innovation	–	++	0	+	0	0
2. New/improved launch facilities/processes	–	0	0	++	0	–
3. Near/long term price decreases	– –	+	++	+	++	++

Notes on Affordability:

- Buying launches in stable, lot buys would have significant payoff by decreasing prices in both the near and long term. However, its potential impact on technological innovation and improving facilities and processes would depend on the extent that the acquisition strategies and contract provisions associated with the long-term buys included incentives or requirements for capability enhancement. Otherwise, this action could make permanent existing technologies, facilities, and suppliers and not facilitate new developments or entries.
- Over the long term, increased U.S. government R&D and innovation incentives should significantly advance technological innovation, resulting in better performance, decreased prices, or both.

D. Feasibility	USG select single launch provider	USG increase R&D, innovation incentives	USG buy launches in stable, lot buys	USG modernize ranges, regulations and processes	USG provide direct subsidies to U.S. launch providers	USG allow commercial vendors to pay only marginal cost of launch
1. Consistency w/existing laws/policies/objectives/culture	–	+	–	+	– –	–
2. Minimize complexity of implementation	0	+	+	–	+	– –
3. Minimize resource requirements	0	–	+	– –	– –	–
4. Leverages market dynamics	– –	–	+	0	– –	++

Notes on Feasibility:

- Selecting a single launch provider is inconsistent with leveraging market dynamics since it would establish a monopoly and eliminate market pressures to compete and innovate.

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Notes on Feasibility (*continued*):

- Selecting a single launch provider is inconsistent with leveraging market dynamics since it would establish a monopoly and eliminate market pressures to compete and innovate.
- Most of these actions would be inconsistent with existing policies. Only increasing R&D or incentives or modernizing ranges and processes are consistent with existing policy. The R&D option is consistent with the current proposed NASA budget, which includes a substantial request for R&D focused on heavy lift propulsion technologies. Modernizing ranges and providing direct subsidies would carry significant costs. Direct subsidies also would have to overcome cultural objections within the DoD and may be incompatible with international trade agreements.
- Buying launches in stable, lot buys would require some existing laws to be changed, although the relevant laws, policies, and culture do not appear to be internally consistent themselves.

	USG select single launch provider	USG increase R&D, innovation incentives	USG buy launches in stable, lot buys	USG modernize ranges, regulations and processes	USG provide direct subsidies to U.S. launch providers	USG allow commercial vendors to pay only marginal cost of launch
E. Timeliness (time to implement/get results)	++	–	+	–	+	+

Note on Timeliness:

- Increasing R&D and modernizing ranges would take a significant amount of time both to implement and to see results.

Note: Marginal cost evaluations were addressed in Option Set 2, and are not addressed in Option Set 3.

Option Set 4: Enhance demand for launch

Table of evaluation criteria

	Possible actions			
A. Reliability	**USG enhance business environment**	**USG fund R&D for low-cost access**	**USG reduce size, complexity and cost of satellites**	**USG increase use of commercial satellite services via long-term contracting**
1. Maximize efficient U.S. infrastructure/processes	+	++	++	0
2. Maximize safe/effective U.S. throughput	++	++	++	+
3. Maximize U.S. responsiveness to change	++	++	++	0
4. Minimize U.S. technical failure risk	+	++	++	0
5. Minimize U.S. disaster impact	0	0	+	0
6. Minimize U.S. priority schedule disruptions	0	0	0	+
7. Minimize U.S. foreign nation delay/deny risk	0	+	0	0

Note on Reliability:

- The major objective of this option set is to work within the existing market structure to increase U.S. commercial launch demand and competition. This should facilitate robust and stable workloading and lead to significantly improved efficiencies and effectiveness within the commercial launch industry (facilities and launch vehicles).

B. Security	**USG enhance business environment**	**USG fund R&D for low-cost access**	**USG reduce size, complexity and cost of satellites**	**USG increase use of commercial satellite services via long-term contracting**
1. Appropriate technology dissemination	0	+	0	–
2. Limit potential performance compromise	0	+	0	–

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3. Strengthen industrial base	++	++	++	0

Note on Security:

- Although this option set generally would strengthen U.S. commercial launch security, increased U.S. government use of commercial satellite services via long-term contracting action could have a slightly negative impact by introducing more opportunities for non-U.S. actor involvement in payloads important to U.S. national security, thus increasing risk of inappropriate technology dissemination and potential performance compromise.

C. Affordability	USG enhance business environment	USG fund R&D for low-cost access	USG reduce size, complexity and cost of satellites	USG increase use of commercial satellite services via long-term contracting
1. Technological innovation	++	++	++	0
2. New/improved launch facilities/processes	+	++	++	0
3. Near/long term price decreases	+	++	++	++

Notes on Affordability:

- Affordability within the existing market structure is the primary focus of this option, and it generally would have a significant positive impact on each affordability criterion.
- However, increased U.S. government use of commercial satellite services via long-term contracting likely would have little effect on enhancing technological innovation of launch vehicles or facilitating new or improved launch facilities and processes. The U.S. government would be buying existing capability, which would not drive improvements in launch.

D. Feasibility	USG enhance business environment	USG fund R&D for low-cost access	USG reduce size, complexity and cost of satellites	USG increase use of commercial satellite services via long-term contracting
1. Consistency with existing laws/policies/objectives/culture	–	–	–	+
2. Minimize complexity of implementation	–	+	–	+
3. Minimize resource requirements	–	–	–	+

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Notes on Feasibility:

- Except for U.S. government use of commercial satellite services, possible actions within this option generally would require cultural and acquisition strategy shifts away from larger and fewer satellites and programs. In the near term, changing culture and adding R&D funding could be expected to require significant resources, both financial and political.
- Government funding R&D for low-cost access would require a significant shift in policy but would be relatively straightforward to implement once policy was adjusted.
- Reducing the size, complexity, and cost of satellites is somewhat contrary to cultural trends within the national security community, particularly within the intelligence community. This change also would be technically complex to implement and would likely require significant resources.

	USG enhance business environment	USG fund R&D for low-cost access	USG reduce size, complexity and cost of satellites	USG increase use of commercial satellite services via long-term contracting
E. Timeliness (time to implement/get results)	– –	– –	–	++

Note on Timeliness:

- Except for increased use of commercial satellite services, which already are being implemented, time lines to implement and obtain results with these actions are relatively long in light of the technical, funding, and cultural issues to be overcome.
- Increased government use of commercial satellite services via long-term contracting represents current, albeit emerging, policy, as demonstrated in the new Future COMSATCOM Services Acquisition strategy at the Defense Information Systems Agency. However, some resistance remains to be overcome.

Option Summary

This evaluation is intended to present policymakers with a clearer understanding of options, and the extent to which each option facilitates or does not facilitate desirable commercial space launch market industrial base attributes. The option sets, and possible actions resident within each option, are not mutually exclusive. They should be viewed as an evaluated menu of potential approaches meriting consideration, recognizing that the various actions can be crafted into other option sets.

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